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IF it were not for that something called hope, the world would be filled with discouraged, listless human beings who would merely exist.

Hope braces a man up, makes him battle against odds, encourages him to undertake enterprises that appear to be doomed to disaster before their completion.

It is hope that incites the laborer to work from ten to twelve hours a day for $1.50. He hopes the boss will recognize his worth and increase his wages to $2, and although his hopes are rarely realized he keeps plodding on.

It was hope that prompted a correspondent to write: "If we make good in the plant the company will make good in the pay envelop." If this engineer is of the average caliber, he is getting between fifteen and eighteen dollars a week. He has served his company faithfully from the beginning of his service; no work has been too arduous, no hours too long, no Sunday so sacred and no time so precious that he could not give all to his company. His hours do not begin and end with the blowing of the whistle; often he is the only one employed in the steam plant, and does his own firing besides running the engine.

He has been spurred on by the hope that his faithful service would be recognized in time. His ambition to succeed has been such that hours have been spent in study and planning improvements which will bring about greater economy.

What is the result? Occasionally a case is heard of where the cherished hope of a voluntary increase in wage has been realized, but in the majority of instances the engineer's ability, although recognized, goes unrewarded.

If the engineer is offered a more remunerative position in another plant, the company, knowing of his ability and his real worth to them, then usually offers him an increase in wages equal to that accompanying the new position. This means that the engineer had not been getting what the company knew he was worth. The engineer had not been getting what was due him because he had waited in the hope that the company would voluntarily pay him what he was worth, and not at the rate at which another engineer could be hired.

Men have often refused inducements to sever their connections because the company has used them square, and entertaining such feelings are sure to give the best of service for value received.

A dissatisfied engineer is a detriment to the success of any company. His heart is not in his work, and he does no more than is necessary to hold his job,—thereby costing his company a good many dollars by his indifference.

Apparently, the fact that an engineer appreciates recognition of his worth is lost sight of and, so long as the wheels turn, the company seems to be satisfied; the cost of coal and supplies is of little account, but the engineer's wages loom up in an alarming manner.

Some day we hope that the plant owner will see the wisdom of voluntarily increasing the pay of his engineer. It will not cost him much—he will get most, if not all, of it back by a more strict attention to affairs by the engineer. There is no better way of increasing the efficiency of a man than by stimulating his efforts by an occasional increase in his pay envelop.

The Steam Turbine in Germany

By F. E. Junge

The construction and economy of the Melms & Pfenninger turbine, which is of the impulse type in the high-pressure element and of Parsons design in the intermediate and low-pressure stages.

The Maffei-Schwartzkopff Works, of Berlin, build turbines of the Melms & Pfenninger type. This type was originally developed by a firm of like name in Munich-Hierschau and is now manufactured by these firms on the Continent: the Maffei Locomotive Works, in Munich; the Kolben Electric Manufacturing Company and the machine works of (formerly) Breitfeld, Denek & Co., in Prague; and the Schichau Shipbuilding Company in Elbing and Dantzic. Similar in principle to the Brown, Boveri turbine, the Melms & Pfenninger turbine is the outcome of a successful attempt to combine the advantages of the impulse type, in the high-pressure element, with the recognized high efficiency of the Parsons type in the intermediate- and low-pressure elements.

To provide for good packing between the various elements the pure-impulse type of turbine must have a small shaft, and to provide for the bending of this shaft the clearances between it and the walls of the diaphragm, forming the partitions between successive wheels, must be made amply large. These requirements work at cross purposes. The steam which leaks past the clearance without doing useful work is unavoidable. Moreover, wheels running in a space filled with high-pressure steam involve additional losses through disk friction. Finally, the complicated structure of the pure-impulse type and the expensive machining of its various parts make the total cost of manufacture high.

The pure-reaction type, on the other hand, in order to have sufficient blade hight of the first rows, must have a very small drum diameter on the high-pressure side, a certain length of the high-pressure blades being necessary to maintain a favorable ratio of the useful blade area to the radial or clearance between the fixed and moving parts. Hence, to attain a given turning moment an increased number of rows is required, and the length of the high-pressure element becomes abnormally long. The length of the high-pressure section of a Parsons turbine, contributing one-quarter of the total useful work, is often three-quarters of the length of the remainder of the turbine, while the efficiency of the high-pressure end is substantially lower than that of the low-pressure end, the ratio in the case of a marine turbine tested being 55 to 63 per cent. This low efficiency is due to the large amount of high-pressure steam which leaks through the clearances above the blade tips, in spite of the low steam and blade velocities employed. In the case of an impulse turbine, on the other hand, the blade speed is frequently the same at the high-pressure as at the low-pressure end, a condition rendered possible because it is practicable to run impulse turbines with partial admission.

In the partially impinged impulse section of the Melms & Pfenninger turbine a considerable portion of the available pressure drop is utilized—before the steam is conducted to the reaction part for further expanding. Thus the first reaction blades can be made much longer than the shortest blades of an equivalent pure-impulse turbine, and the radial and axial clearances are kept amply large without endangering the steam economy of the turbine. In the impulse part of this turbine a fivefold expansion of steam

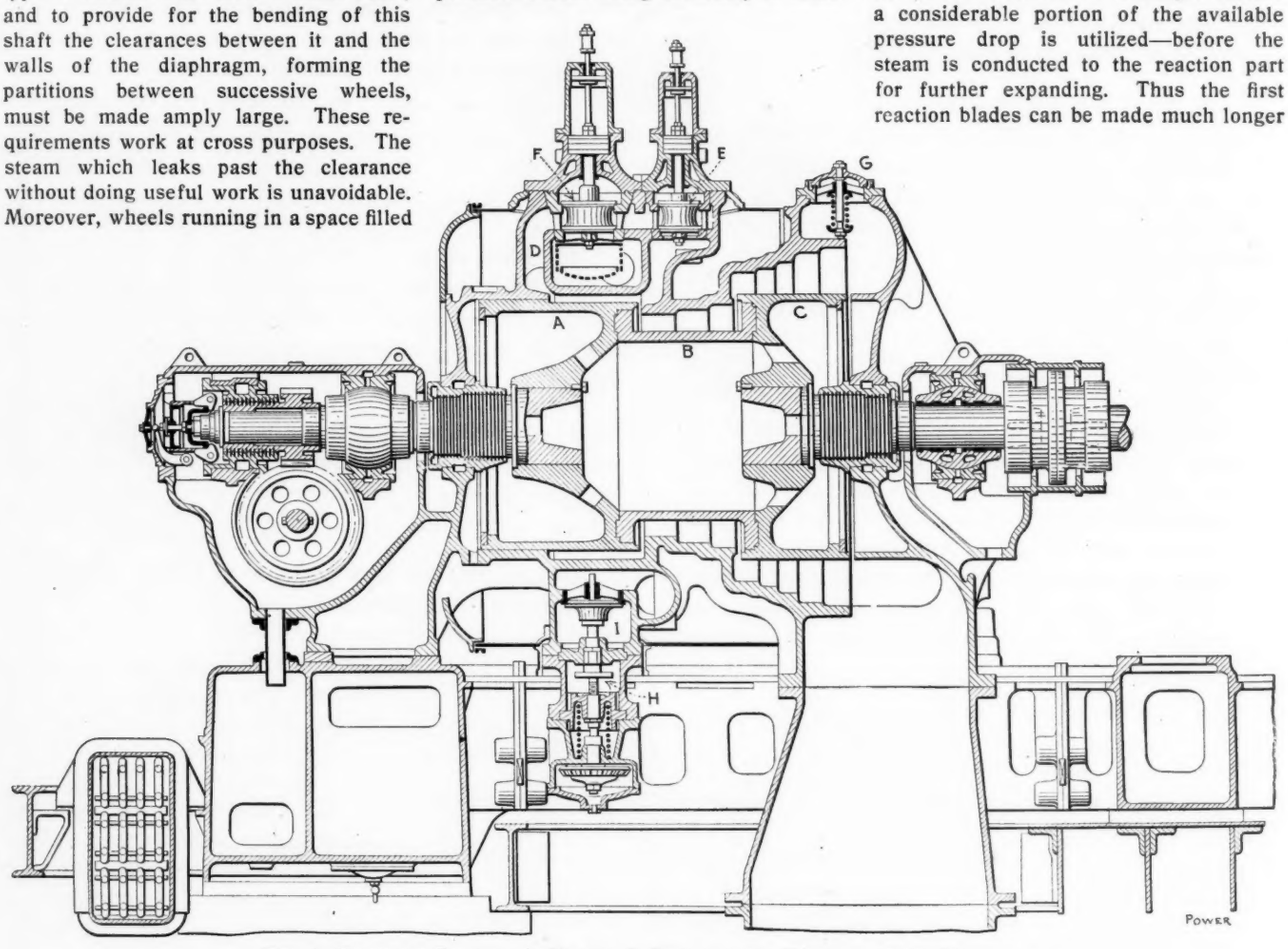


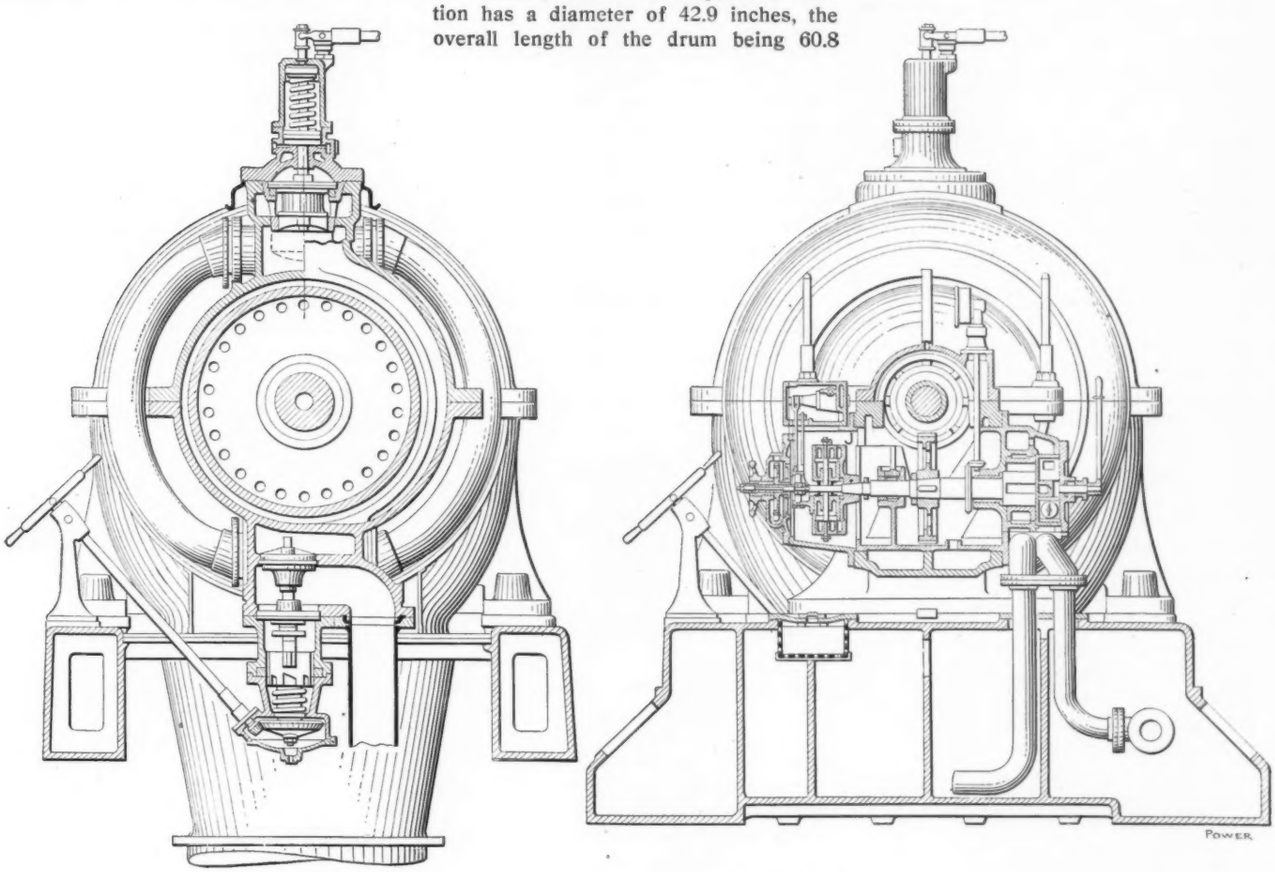
FIG. 1. ORIGINAL DESIGN OF MELMS & PFENNINGER TURBINE, 3000 HORSEPOWER

takes place as against a hundredfold expansion in an equivalent number of blades of a pure-impulse turbine. Hence the drawbacks of the latter type are minimized, especially so because the packing of the various elements is done by means of slots which are regulable in axial direction, and the respective clearances can be easily adjusted to the comparatively small pressure drop of each stage. That the efficiency of the impulse section in the Melms & Pfenninger combination is higher than that of a corresponding section of pure-reaction turbines is proved by the favorable results of several tests made on turbines of from 100 to 5000 horsepower capacity referred to later.

From the accompanying Figs. 1, 2 and 3, it may be seen that the steam enters the turbine through the governor valve *F*, the position of which is controlled by a steam relay, whence it proceeds into the impulse section of drum *A*. Its escape to the left is checked by a labyrinth packing. At the end of the impulse section the drum is reduced in diameter, and the pressure of the steam on the shoulder to the left serves to balance the axial thrust of the steam to the right, as it flows on through the reaction blading in drum sections *B* and *C*. In the case of an overload steam is admitted directly to the reaction part of the turbine through the bypass valve *E*. A relief valve is fitted at *G* which opens if the pressure in the exhaust branch rises above that of the atmosphere, and thus prevents a possible rupture of the condenser. A gland *H* is fitted between the exhaust pipe and the top of the condenser, and over this gland a water seal is constantly maintained to prevent any possibility of air leakage.

The turbine illustrated is rated to develop 3000 horsepower when running at 1500 revolutions per minute. The drum diameter in section *A* is 40.2 inches, and its thickness 1⅜ inches. At the intermediate section *B* the drum diameter is 30.6 inches, while the low-pressure section has a diameter of 42.9 inches, the overall length of the drum being 60.8 inches, as compared with 8 feet, the usual length of arm for a pure-reaction turbine of corresponding output. Fig. 4 shows the form of packing used to minimize leakage between the guide-blade diaphragms and the moving drums. The admission being partial, the guide blades occupy only a portion of the total area of this diaphragm, which consists for the main part of a solid ring 0.04 inch thick, and in the case of the turbine shown in Figs. 1, 2 and 3 about 1¼ inches deep in the radial direction. At certain symmetrically arranged points the ring is cut away and a foundation strip carrying 10 or more nickel-steel guide blades inserted; this foundation strip is calked into place. A shrouding of L-section passes right round the inner edge of the diaphragm and extends into a groove cut in the drum. Leakage of steam can only then take place through the clearance marked, and this clearance is adjustable by moving the rotor axially by means of the micrometer screws provided for this purpose at the turbine thrust block. Hereby the leakage losses of the drum arrangement are brought down to a similar low figure as attends the employment of disk wheels. The makers state that owing to the short length and large diameter of the drum it has been found quite practicable to work with a clearance of but 10 mils between the nearest points of the opposed fixed and moving surfaces.

The impulse blades, Fig. 5, are of the usual symmetrical pattern, let into a foundation ring. This ring is secured to the drum by double calking strips, one of a soft brass and the other of steel. Fig. 4 shows diagrammatically the joint ready for calking, and after this operation has been finished, when the steel key piece is bent over as indicated. The rim which connects the outer ends of the impulse blades and whose cross-section approaches the form of a sickle, is riveted to the blade tips, increases their stiffness, keeps them in proper distance and closes the channels of the rotor, thereby reducing windage losses. The glands at each



FIGS. 2 AND 3. SECTIONAL VIEWS OF TURBINE

end are also fitted with labyrinth packings, the clearances of which are adjustable in the same way as those between the diaphragms of the impulse section and the rotor drum. These glands are packed with the steam exhausted from the governor relays, which is admitted to the annular channel shown round the

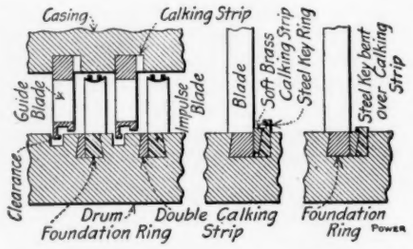


FIG. 4. BLADE ATTACHMENT; LEFT, IMPULSE; RIGHT, REACTION

center of each gland. In order to prevent troubles arising from differential expansion of the rotor and of the casing, the gland bush at the low-pressure end is itself adjustable in the axial direction. The clearances here are adjusted with the turbine running, after which the bush is locked in place. When cold the clearances here naturally increase, but with the rotor warm and running they are so small that there is very little gland leakage. For details of blade attachment, see Figs. 4 to 7.

In some turbines, glands with adjustable clearances are employed at the high-pressure end only, larger and nonadjustable clearances being used at the low-pressure end. This arrangement has, however, the disadvantage that the steam lost by gland leakage becomes at low loads a very considerable fraction of the total steam passed through the turbine. On a 2000-kilowatt turbine the loss at the low-pressure gland alone may thus amount to 500 pounds per hour, or about 5 per cent. of the total steam supply at quarter load. A 600-horsepower Melms & Pfenninger turbine, built by the firm of Breitfeld, Danek & Co., in Prague, whose packing consists of 18 labyrinth chambers of the kind shown in Fig. 8, has a clearance when cold of 0.008 inch, which increases to 0.01 inch during operation. Hence with a diameter of 96 inches the clearance area through which leakage may occur is

$$(96 \times \pi \times 0.01) - 0.46 = 2.56$$
square inches

The smallness of this area and the largeness of the number of labyrinths employed make leakage losses through gland packings a negligible quantity.

The main journals of the turbine shown measure 7.1 inches in diameter by 14.96 inches long. The bearings are of white metal in spherical-seated cast-iron bushes, and are lubricated with oil under pressure in the usual way. Provision is also made for the water cooling of these bearings, but this really is only in the nature of a standby, since the oil draining away from the bearings is passed through the cooler, shown to the left in Fig. 1, before being pumped again into the bearings. The temperature of the latter, when the turbine is running, is normally not more than 105 to 120 degrees Fahrenheit. The thrust block is of the pattern usual in reaction turbines, the upper and lower halves being independently adjustable in the axial direction, so that by moving the one or the other by the micrometer screws fitted, the axial clearances of the labyrinths and diaphragms can be adjusted. At its outer end the shaft carries an emergency governor. Should the speed ever become excessive, the pivoted arms fly out, thrusting to the left the small central spindle, which operates a knock-out gear, releasing the spring-operated shutoff valve, shown below the turbine at *I*, Fig. 1.

This valve is of the single-beat type, and constitutes also the main steam stop valve, being operated by bevel gearing as indicated in Fig. 2. The spindle is screwed and works in a nut formed in the bushing shown at *H*. This bushing is normally locked against movement in the axial direction by stops. By means of the emergency governor acting through gear teeth the bush can be so rotated as to clear these stops, and can then move axially, thus allowing the valve to close under the combined influence of the steam pressure and the spring shown in position around the valve spindle in Fig. 2. From valve *I* the steam travels through two pipes arranged symmetrically on both sides of the turbine to the governor valve *F*. The form of the casing is thus simplified and becomes free from harmful strains which otherwise would occur owing to unequal heating. In order to retain the impurities the live steam has to pass a sieve before entering channel *D* and the blades.

Throttle regulation as employed in the Melms & Pfenninger turbine is essentially the same as in all Parsons turbines. The ordinary governor is mounted on a transverse shaft, as indicated at *J*, Fig. 3, which rotates at some 200 revolutions per minute. It consists of spring-controlled weights sliding in guides, and moving in or out as the speed, and consequently the centrifugal force, varies. By sliding collars and bell cranks the movement of these weights is transferred to the relay valves. In the present case the movement of the weights controls the position of the eccentrics which govern the valves admitting the exhausting steam from the relay cylinder shown above the main governor valve in Fig. 1. The throw of the eccentrics is further adjustable by the handwheel shown on the left in Fig. 3, thus affording a means by which the number of revolutions per minute of the turbine shaft can be speeded up or down. Provision is also made for speeding the turbine up or down from the switchboard by means of a small motor driving the worm and wheel shown in place in Fig. 3. At the opposite end of the transverse shaft an oil pump is fitted, and beyond it a hand pump used for priming the bearings with oil in starting up.

The arrangement of a turbine as fitted in place at Riga is shown in Figs. 9 and 10. The output of the Riga unit is 1700 kilowatts, and the short length of the turbine as compared with the generator is very noticeable. The condenser is, as is usual, arranged immediately under the turbine. The inlet measures 40x27½ inches. A large gate valve is provided for cutting out the condenser when it is necessary to run the turbine noncondensing. The main steam pipe is arranged below the floor level and is fitted with a separator as indicated. The circulating and air pumps, shown in plan in Fig. 9, are both motor driven.

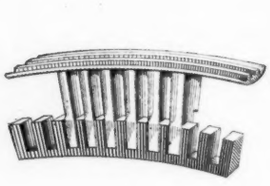


FIG. 5. IMPULSE BLADES

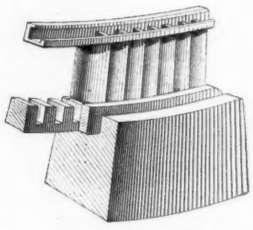


FIG. 6. GUIDE BLADES

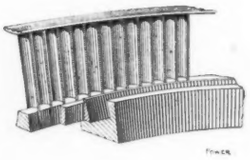


FIG. 7. REACTION BLADES

For small machines up to about 500 kilowatts, the type of turbine illustrated in Fig. 11 is supplied, particularly where space is cramped and low rotary speeds are required. There is a demand for a machine of 300 horsepower running at 2000 revolutions only, and for 100-horsepower turbines running at but 3000 revolutions. These low rotary speeds are best secured by at least a partial adoption of the principle of velocity compounding. In the machine illustrated the high-pressure end is constructed on what is com-

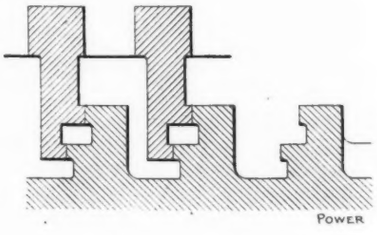
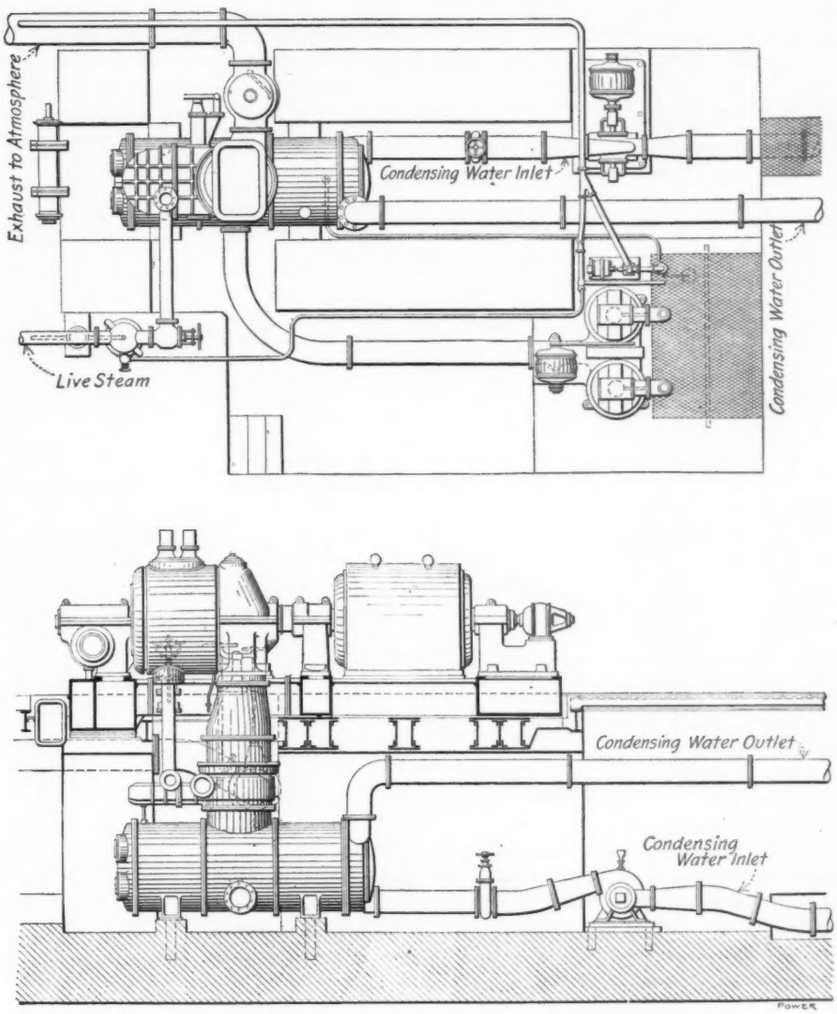


FIG 8. LABYRINTH CHAMBERS



FIGS. 9 AND 10. PLAN AND ELEVATION OF TURBINE INSTALLED AT RIGA

monly known as the Curtis principle. It consists of a single wheel carrying three rows of moving blades between which are two rows of fixed blades, these latter extending only partially around the cylinder. The steam enters the cylinder through the symmetrically placed sets of nozzles, from which it issues at a high velocity, and then, without further change of pressure, passes on through the successive rows of fixed and moving blades.

Though the efficiency of a three-stage velocity-compounded wheel is only about three-quarters of that possible with a single wheel doing the same work, it will develop this efficiency at a blade speed equal to between one-sixth and one-seventh that of the steam, while with a single wheel to get the best efficiency the blade speed should be between one-half and one-third that of the steam. Run at one-sixth the velocity of the steam, a single wheel will develop only three-quarters as much power as a three-stage velocity wheel run at the same speed, so that the arrangement has great advantages when a low speed and compactness of design are the essentials.

In this type of turbine the drum consists of two parts riveted together, the high-pressure part with its cone-shaped hub being keyed on to the shaft, while the hub of the low-pressure part lined with a bushing slides on a thickened portion of the shaft. The interior of the drum is heated by steam, there being a tube on the high-pressure end for draining the condensate into the exhaust space.

The nozzle block shown in Fig. 12 is made of Siemens-Martin steel, being inserted into the turbine casing and closed

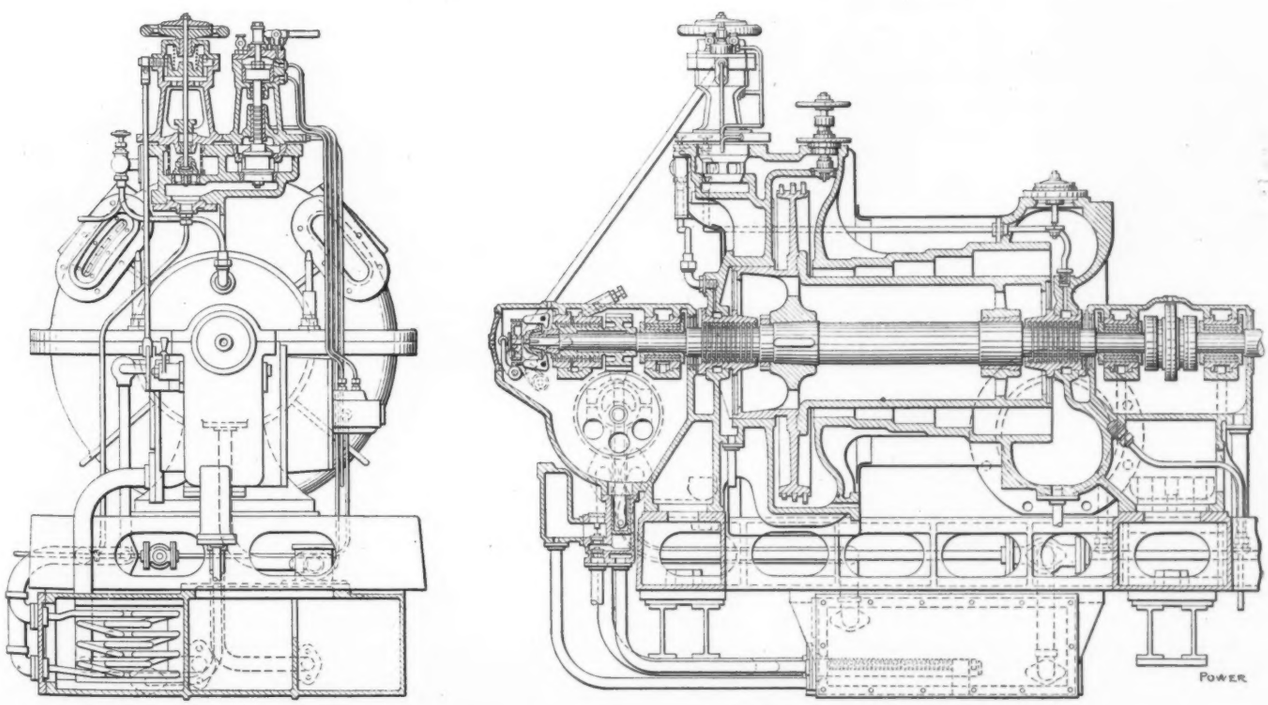


FIG. 11. MELMS & PFENNINGER TURBINE OF 500 HORSEPOWER CAPACITY

by a cover on the side. For capacities of from 150 to 400 kilowatts four to six nozzles are provided in one chamber, while in a second chamber are two nozzles for higher loads. By removing the cover all nozzles can be inspected at once. The construction of the stuffing boxes is the same as the one in the other type previously described, with the difference that live and not exhaust steam is used for packing in case that

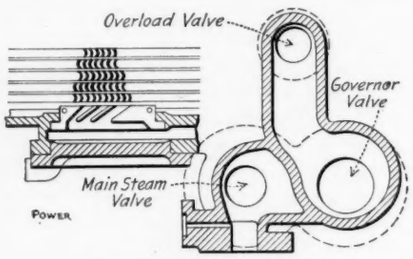


FIG. 12. NOZZLE BLOCK

at varying boiler pressures, governing by oil under pressure instead of by steam is resorted to. Both the main steam and the main governing valves are located side by side on top of the turbine casing. The valve shown to the left in the longitudinal view of Fig. 11, is at once the main stop valve and the emergency valve, being tripped by a special governor in case of a runaway. The main governor valve at the right is operated by an oil relay controlled by a governor on the transverse shaft. This valve is shown in detail in Fig. 13. The distribu-

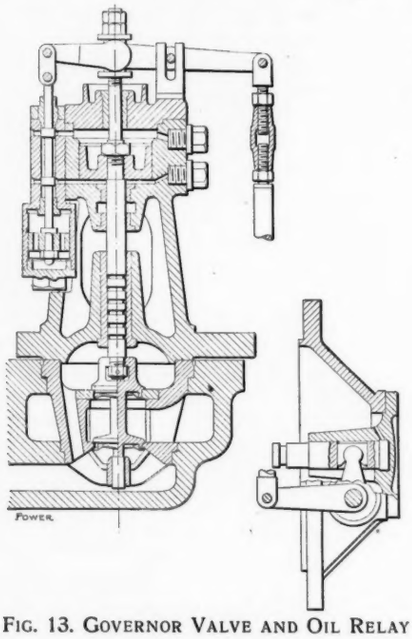


FIG. 13. GOVERNOR VALVE AND OIL RELAY

tion of the steam to these valves and their connection with the overload valve, as well as the conduction of steam to the nozzle chest, is shown in Fig. 12. The turbine casing is divided horizontally and carries a safety valve on the low-pressure side. The bearings are of the concentric-sleeve type, being cast in one piece with the main casing, and rest on a rigid foundation frame.

The following is the résumé of a test recently made by Professor Schröter, of Munich, on a 200-kilowatt turbine built for the Imperial Torpedo Shops in Friedrichsort, near Kiel. In view of the fact that most builders are somewhat reluctant to publish the results of tests with small turbine units, because the leakage and other losses are proportionately of more importance in the smaller sizes and the steam consumption is higher than that of the larger, this test is of special interest.

TESTS OF A 200-KILOWATT MELMS & PFENNINGER TURBINE

			1	2	3	4	5	6
1	No. of test							
2	Load in per cent. of full load		120	100	75	50	25	No load excited
3	Duration of test in minutes		24.97	60.28	45.35	44.15	42.32	60.43
4	Absolute pressure in pounds per square inch and temperature deg. F. at the turbine inlet	Pressure	163.5	155	158.5	159.5	160.7	158.8
5		Temperature	478.8	446	441	408.5	382	
6		Temperature of saturated steam	365	360	362	362.5	368	362
7		Superheat	113.8	86	79.3	46	14	
8	Absolute pressure in pounds per square inch and temperature deg. F. at the exhaust pipe	Inches of mercury	1.23	1.045	0.88	0.83	0.855	0.915
9		Pressure in pounds per square inch	0.607	0.508	0.431	0.409	0.419	0.449
10		Saturation temperature	85.8	80.1	75	73.7	74.3	76.6
11		Barometer	.....	28.8 inches				
12		Per cent. of the absolute vacuum	95.8	96.4	96.9	97.1	97	96.8
13	Electrical and effective power	Revolutions per minute	3022	3025	3025	3022	3025	3035
14		Voltage	241.2	236.7	243.6	240.7	243.1	240
15		Amperes	1083.3	870.7	521	423.2	216.4	
16		Kilowatts at switchboard	261.5	206	151.2	101.8	52.6	
17		Electrical power in brake horsepower	355.5	280	205.5	138.4	71.5	
18		Efficiency of generator	92.7	91.5	89	85	74.7	
19		Effective brake horsepower	383.5	306	230.8	162.7	95.7	22.5
20	Condensed-water data	Total in pounds	2177	4360	2620	1960	1308	875
21		Duration in minutes	24.97	60.28	45.35	44.15	42.32	60.43
22		Condensed water (in pounds per hour)	5230	4340	3475	2660	1850	868
23		Condensed water per kilowatt-hour	20.02	21.02	22.9	26.15	35.2	
24		Condensed water per brake horsepower per hour	13.43	14.15	15.28	16.35	19.35	38.6

The peculiarity of the condensing plant is that one condenser is so arranged that either turbine or both can exhaust into it. But during the test the exhaust branch connected to the turbine not in use was hermetically closed. The air pump and circulating pump had electric drive, but, as is usual, the work absorbed by these pumps is not included in the results.

The power output of the direct-current generator was absorbed by a water

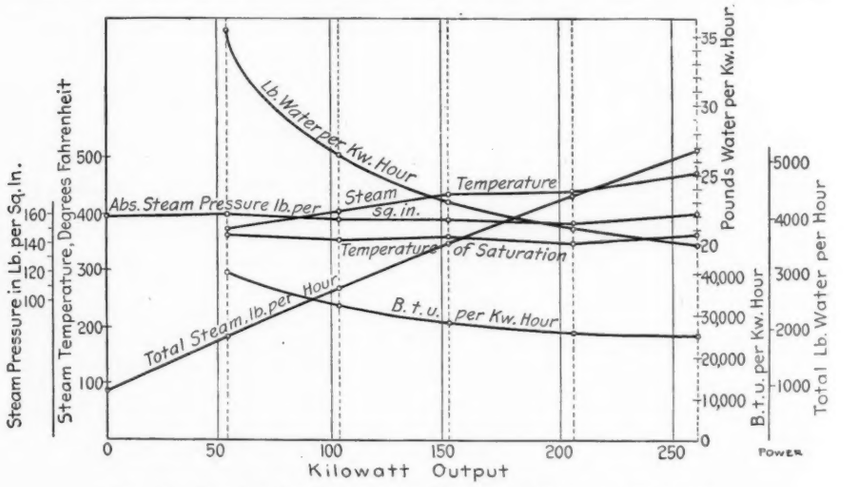


FIG. 14. CURVES SHOW ACTUAL VALUES OBTAINED IN TESTS

The object of the test was primarily to measure the economic efficiency of the turbine at various loads. Shortness of time did not allow arrangements for the observation of other data of scientific interest, as the turbine was dismantled the next day for delivery. The plant consisted of two turbines, both of them

rheostat, which worked well and permitted a regulation of the load with but small variations. The voltage was measured with a standard instrument belonging to the technical high school, while the switchboard ammeter was compared with the standard instrument of the city electric-power works laboratory. The

pressure and temperature were measured with the usual instruments, the vacuum with a mercury column in terms of the percentage of the barometric hight. The revolutions were obtained by timing 200 strokes of the eccentric rod with a one-fifth-second stop watch.

The condensed water was measured in tanks belonging to the outfit of the test room, which were carefully gaged by filling with weighed quantities of water, and, with due regard to the temperature. A constant time interval between the passage of the water level past each 50-liter mark showed without doubt when the equilibrium aimed at before each test was obtained. In the accompanying table of results only the average of the readings is given. The temperature of the superheated steam is not constant, as is usual with built-in superheaters, the temperature varying with the change of the load, although great pains were taken to keep the temperature constant. The normal steam temperature required at the inlet is 446 degrees Fahrenheit, but since in actual service constant steam temperature can no more be obtained than in this case, a calculation of the results reduced to a constant temperature was not made. The vacuum showed only small variations with a change of the load, and no allowance was made in the calculation for these variations; the high degree of vacuum of the condensing plant is to be noticed.

In calculating the effective work in brake horsepower, the results of tests performed in the testing department of the Berliner Maschinenbau Aktiengesellschaft, vorm. L. Schwartzkopff, Berlin, were used for estimating the efficiency of the generator. The data given by the above company with regard to the resistances of the generator were used to calculate the work supplied to the generator at no load with the field magnets excited. And with these data and the interpolation of the graphic representation of the curve of steam consumption per brake horsepower-hour the steam consumption of the turbine with no load was obtained with considerable accuracy. The graphic representation, Fig. 14, of the main results, both as to kilowatts and to effective power, shows throughout the regularity of the data.

Convenient Oil Pumps

The illustration, Fig. 1, shows a home-made oil pump which saves considerable manual labor and works to perfection. It consists of a brass pump cylinder. One end is screwed into a tee connection and the other end is fitted with a packing nut for the plunger. To the tee connection two nipples are secured upon which two check valves are placed as shown. One acts as the suction valve and the other as the discharge valve of the pump. The discharge valve is fitted with a pet cock so that the line between it and the oil tank can be relieved of air and oil if desired.

To the check valve a tee connection is fitted by means of a nipple and an air chamber secured to the side outlet of the tee. This air chamber is made of an old copper float soldered to a short nipple. The pipe extension beyond the air chamber is connected to a hose which can be inserted in a barrel and the oil may be pumped into the oil tank located in the engine room above; the pump and check valves are in the basement. The pump derives its motion from the wrist-plate of the exhaust valves on the steam engine, so that the pump is always in operation and ready for use so long as the engine is running. The pipe *C* is for the purpose of blowing steam on the check valve in cold weather to heat the oil and facilitate its flow.

In Fig. 2 is shown a second pump that is operated from the same wristplate and is used to lubricate the condenser located in the basement.

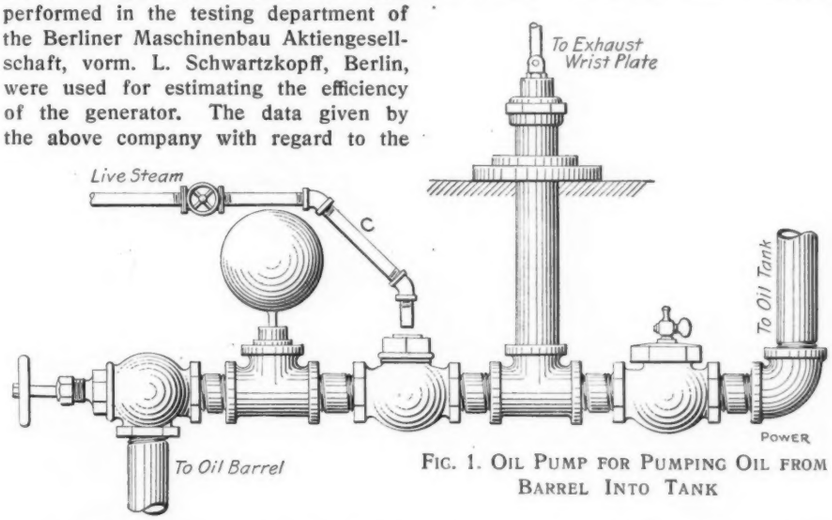


FIG. 1. OIL PUMP FOR PUMPING OIL FROM BARREL INTO TANK

Attached to one side of the pump is a pipe which connects with a small oil reservoir to which is fitted a sight glass. The discharge of the pump is connected to the steam pipe running to the condenser. A check valve is inserted to prevent the steam from blowing into the pump.

The feed of oil is regulated by means of a needle valve in the sight glass, and as the oil flows to the pump cylinder the plunger in its downward movement forces the oil into the steam pipe leading to the condenser. As soon as the plunger has dropped below the inlet pipe the oil cannot, of course, be forced back into the oil tank.

This device saves many steps from the engine room to the condenser to see that it is being lubricated, as it is only necessary to note the flow of oil through the sight glass.

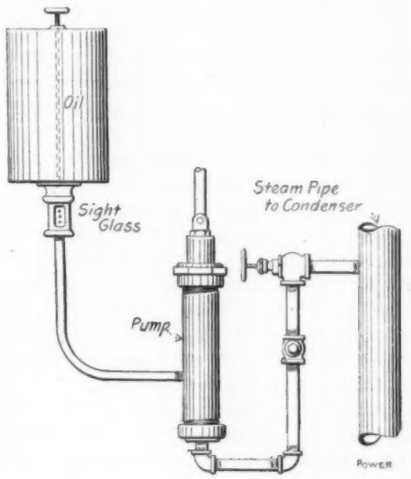


FIG. 2. CONDENSER LUBRICATING PUMP

A pertinent illustration of the effect of high temperature upon cast iron was given in the course of the discussion on a paper on "Superheated Steam in Marine Engines" recently read before the Northeast Coast Institute of Engineers. One of the speakers mentioned as a well authenticated fact that where superheated steam was used in turbines the growth of the turbine casings at the dummy end had been in some cases so marked that the steam consumption was increased to such an extent that new dummy plates in many cases have had to be put in. The same speaker also mentioned another effect on cast iron produced by exposure to high superheat for several years, the iron occasionally becoming so deteriorated that it can be cut with a knife like plumbago, which in appearance it very much resembles. This kind of decay is not unfamiliar to those who have had experience of the working of economizers, the upper portions of which are sometimes found decayed in this way. Investigation has shown that it generally occurs in installations where the apparatus has been exposed to high temperatures and has not been kept filled with water. No satisfactory explanation has, we believe, been offered to account for this chemical change, though it has obviously a practical bearing, and we suggest the matter as one well deserving of research by chemists and metallurgists.—*The Mechanical Engineer.*

Design of Steam Power Plants

CONDENSERS

By William F. Fischer

Items to be considered in the selection of a condenser; saving effected, and method of calculating necessary circulating water.

In power plants having water available in sufficient quantities for condensing purposes, the horsepower of the main engines may be increased and the fuel cost per horsepower materially reduced by installing efficient condensing apparatus. The real saving made possible by the installation of condensers depends on the cost of fuel, cost of condensing water, cost of pumping, upkeep, repairs, etc., on the condensers, and the cost of boiler-feed water.

The main object of a condenser is to remove a large part of the back pressure from the exhaust side of the engine piston, thus increasing the power of the engine without increasing the fuel consumption, or by decreasing the fuel consumption with the same power output. In noncondensing engines where the steam exhausts direct to the atmosphere, at least, the pressure of the atmosphere must act against the exhaust side of the piston, but in practice the back pressure is seldom less than 17 or 18 pounds absolute; whereas the back pressure acting against the exhaust side of the piston of a good condensing engine is often as low as 2 pounds absolute.

If an engine is running without a condenser, at a mean effective pressure of, say, 50 pounds per square inch, and a condenser is added, removing, say, 14 pounds of the back pressure, the mean effective pressure would be increased theoretically to 64 pounds and the power of the engine would be correspondingly increased.

If the work done by the engine, after installing the condenser, remains the same, the mean effective pressure may be reduced again to 50 pounds by cutting off the steam earlier in the stroke and thus effecting a saving in steam consumption. Therefore, if the mean effective pressure produced by the condenser is known, one may readily estimate the horsepower added by the condenser.

If it is desired to find the horsepower added by the condenser, the following formula may be employed:

$$G = \frac{ARS}{33{,}000}$$

where

G = Gain in horsepower due to the condenser;

A = Area of piston in square inches;

R = Reduction in back pressure in pounds per square inch;

S = Piston speed in feet per minute.

The reduction in back pressure R on the engine piston may be estimated as follows:

$$R = B - \left(\frac{30 - V}{2.04}\right)$$

where

B = Absolute back pressure in pounds per square inch on the engine piston when running noncondensing;

V = Vacuum in inches of mercury (referred to a 30-inch barometer) produced by the condenser.

SAVING IN STEAM DUE TO CONDENSER

Generally speaking, a noncondensing engine requires from 20 to 30 per cent. more steam per horsepower-hour than a condensing engine of the same power. If a condenser be added to a noncondensing engine of, say, 200 horsepower, running at 100 revolutions per minute and the load and speed be kept the same after adding the condenser, the governor will produce earlier cutoff, thus lowering the mean forward pressure of the steam, and the mean effective pressure will remain constant.

Suppose cutoff occurred at ¼ stroke when running noncondensing and at ⅙ stroke when running condensing, neglecting clearance, the saving in steam per stroke is the difference between ¼ and ⅙ the piston displacement, or

$$\frac{0.25 - 0.166}{0.25} \times 100 = 33 \text{ per cent.}$$

Neglecting friction and other losses, the theoretical mean effective pressure may be determined as follows:

$$M.e.p. = P \times \frac{(1 + hyp.\ log.\ r)}{r} - p$$

where

P = Absolute initial pressure in pounds per square inch;

p = Absolute back pressure in pounds per square inch;

and

r = Ratio of expansion = $\frac{\text{Length of stroke} + \text{clearance}}{\text{Distance to cutoff} + \text{clearance}}$

Table 1, showing the mean pressure per pound of initial pressure, with different clearances and cutoffs, is in condensed form as taken from "The Steam Engine Indicator," by F. R. Low.

Assume a simple noncondensing engine having a clearance of 6 per cent. and cutting off at 0.25 of the stroke. Let the steam pressure at the throttle be 150 pounds absolute and the back pressure 17 pounds absolute. It is also assumed that the initial pressure in the cylinder is the same as the pressure at the throttle. In the column headed "6 per cent. clearance," opposite ¼ cutoff, the mean pressure per pound of initial pressure will be found to equal 0.6312. This multiplied by the initial pressure is

$$150 \times 0.6312 = 94.68 \text{ pounds}$$

which is the mean forward pressure of the steam. Subtracting the absolute back pressure,

$$94.68 - 17 = 77.68 \text{ pounds per square inch}$$

as the mean effective pressure on the piston.

TABLE 1. MEAN PRESSURE PER POUND OF INITIAL, WITH DIFFERENT CLEARANCES AND POINTS OF CUTOFF

Cutoff in Fractions of the Stroke		Percentage of Clearance														
		0	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7
1/10	0.1	0.3303	0.3439	0.3505	0.3568	0.3630	0.3690	0.3750	0.3808	0.3864	0.3919	0.3974	0.4027	0.4076	0.4126
1/8	0.125	0.3849	0.3966	0.4023	0.4078	0.4132	0.4187	0.4237	0.4287	0.4338	0.4386	0.4433	0.4480	0.4527	0.4571
1/6	0.167	0.4662	0.4757	0.4802	0.4844	0.4890	0.4933	0.4973	0.5014	0.5056	0.5096	0.5134	0.5173	0.5210	0.5245
3/16	0.188	0.5013	0.5097	0.5138	0.5181	0.5217	0.5259	0.5295	0.5332	0.5367	0.5405	0.5440	0.5474	0.5511	0.5546
1/5	0.20	0.5219	0.5298	0.5336	0.5376	0.5414	0.5449	0.5482	0.5517	0.5556	0.5588	0.5623	0.5656	0.5687	0.5716
1/4	0.25	0.5966	0.6025	0.6059	0.6090	0.6120	0.6148	0.6174	0.6207	0.6229	0.6258	0.6286	0.6312	0.6336	0.6359
3/10	0.30	0.6609	0.6663	0.6684	0.6712	0.6729	0.6755	0.6779	0.6803	0.6825	0.6845	0.6864	0.6882	0.6911	0.6927
1/3	0.333	0.6988	0.7029	0.7047	0.7076	0.7092	0.7106	0.7132	0.7144	0.7168	0.7190	0.7212	0.7219	0.7239	0.7257
3/8	0.375	0.7433	0.7458	0.7476	0.7494	0.7510	0.7525	0.7539	0.7569	0.7582	0.7593	0.7603	0.7630	0.7639	0.7646
2/5	0.40	0.7665	0.7691	0.7719	0.7729	0.7738	0.7765	0.7772	0.7778	0.7802	0.7806	0.7829	0.7831	0.7853	0.7874
1/2	0.50	0.8466	0.8484	0.8492	0.8503	0.8513	0.8522	0.8530	0.8539	0.8548	0.8556	0.8565	0.8573	0.8582	0.8590
3/5	0.60	0.9064	0.9076	0.9081	0.9087	0.9092	0.9097	0.9102	0.9107	0.9112	0.9117	0.9122	0.9127	0.9132	0.9136
5/8	0.625	0.9188	0.9194	0.9201	0.9206	0.9210	0.9215	0.9220	0.9224	0.9228	0.9233	0.9237	0.9241	0.9245	0.9249
2/3	0.667	0.9371	0.9378	0.9382	0.9385	0.9389	0.9392	0.9396	0.9399	0.9402	0.9405	0.9408	0.9411	0.9415	0.9418
7/10	0.70	0.9497	0.9502	0.9505	0.9508	0.9511	0.9513	0.9516	0.9518	0.9521	0.9524	0.9526	0.9528	0.9531	0.9533
3/4	0.75	0.9657	0.9661	0.9663	0.9665	0.9667	0.9668	0.9670	0.9672	0.9674	0.9675	0.9677	0.9679	0.9680	0.9682

Let it be required to find an approximate point of cutoff which will maintain the same power of the engine when running condensing, with a vacuum of 26 inches, it being understood that the speed and load, and consequently the initial and mean effective pressures, remain the same.

Dividing 26 inches of vacuum by 2.04 gives 12.7 pounds per square inch, and subtracting this from the atmospheric pressure leaves 2 pounds as the approximate absolute back pressure on the piston. The mean pressure ratio for the foregoing conditions may be found by adding the mean effective pressure to the absolute back pressure and dividing by the absolute initial steam pressure.

Substituting the actual values

$$\frac{77.68 + 2}{150} = 0.5312$$

as the mean pressure ratio required.

Referring again to the table and following down the column headed "6 per cent. clearance," 0.5312 will be found to be between the values 0.5173 and 0.5474. Taking 0.5474 as the nearest figure in the table, it is found to correspond to a cutoff of 3/16, or 18.8 per cent. of the stroke.

The approximate saving in steam is

$$\frac{0.25 - 0.188}{0.25} \times 100 = 24.8 \text{ } \textit{per cent.}$$

due to adding the condenser and thereby shortening the cutoff.

If the saving in fuel is assumed to be in direct proportion to the saving in steam the condensing engine in this case will require 24.8 per cent. less fuel than the same engine would when run noncondensing.

Gain in Thermal Efficiency

The gain in thermal efficiency due to adding a condenser may be calculated as follows: Let

E = Thermal efficiency of the engine;

T_1 = Absolute temperature at which the steam is received by the engine;

T_2 = Absolute temperature at which the steam is exhausted from the engine.

Then for a perfect engine,

$$E = \frac{T_1 - T_2}{T_1}$$

The efficiency of an engine may be increased by raising the boiler pressure and thus increasing T_1 or by reducing the back pressure by adding a condenser, thus decreasing T_2, or by doing both. It is evident from the formula that by reducing the back pressure a much greater gain in efficiency results than by raising the boiler pressure a like amount. This is shown in the following examples:

Suppose a noncondensing engine is supplied with steam at 150 pounds absolute, as in the previous example, and exhausts at 17 pounds absolute. The absolute temperature T_1, corresponding to 150 pounds, is

$358.5 + 461 = 819.5$ *degrees Fahrenheit*

and the absolute temperature T_2, corresponding to 17 pounds absolute pressure, is

$219.4 + 461 = 680.4$ *degrees Fahrenheit*

Hence the thermal efficiency is

$$E = \frac{819.5 - 680.4}{819.5} = 0.17$$

or 17 per cent.

Now suppose the boiler pressure be raised from 150 pounds absolute to 200 pounds absolute, and the exhaust pressure kept the same. Then the absolute temperature T_1, corresponding to 200 pounds absolute, is 842.9 degrees Fahrenheit, and the absolute temperature T_2, corresponding to 17 pounds absolute, is 680.4 degrees Fahrenheit. Hence, the thermal efficiency is

$$\frac{842.9 - 680.4}{842.9} = 0.193$$

or 19.3 per cent.

Suppose instead of raising the boiler pressure a condenser be added, reducing the back pressure from 17 pounds to 2 pounds absolute. The absolute temperature T_2, corresponding to 2 pounds absolute, is 587.15 degrees Fahrenheit, and the absolute temperature T_1 as already found was 819.5 degrees Fahrenheit. In this case the thermal efficiency would be

$$\frac{819.5 - 587.15}{819.5} = 0.283$$

or 28.3 per cent.

From the foregoing it is evident that by lowering the exhaust pressure 15 pounds a much greater gain in efficiency is effected than if the boiler pressure had been raised 50 pounds. Owing to the fact that part of the heat is lost by radiation, conduction, cylinder condensation, leakage, imperfect valve action, etc., the efficiencies herein shown are never realized in the actual engine; the calculations apply to a perfect engine only and are merely for comparison.

It should be kept in mind that compound condensing engines are usually so designed that the exhaust valves open when the back pressure is from 6 to 8 pounds absolute in the low-pressure cylinder. This is due to the fact that it is not practical to proportion cylinders to take care of the excessively large volumes of steam produced by expansion to the lower pressures. By consulting the steam tables one can readily see how rapidly the volume increases as the pressure decreases below the figures given. If the exhaust valve opens at, say, 6 pounds absolute (corresponding to a vacuum of approximately 18 inches), it is readily seen that a higher vacuum in the condenser will serve only to diminish the back pressure on the engine piston without affecting the completeness of expansion in the low-pressure cylinder. The exhaust steam after leaving the engine cylinder will expand in the exhaust pipe and condenser from release pressure down to condenser pressure.

Even if it were found practical to expand to a much lower pressure in the low-pressure cylinder, the low temperature of the exhaust would cool the cylinder walls to such an extent as to cause a very rapid increase in cylinder condensation.

Cooling Water for Condensers

In the previous examples no account was taken of the quantity of cooling water required to condense the steam. In any case, the cost of supplying the condensers with cooling water, and the cost of operating the dry-vacuum pump and hotwell pump, the cost of upkeep on the condensing apparatus and the interest and depreciation should all be taken into account when figuring the actual saving due to a condenser.

As the cost of pumping the cooling water depends upon the quantity pumped, and this in turn depends directly upon the amount of heat imparted to each pound of water leaving the condenser, it is desirable that the discharge temperature of the cooling water be close to that of the steam. Also, if water available for condensing purposes is limited, or in localities where the temperature of the water is very high during a large part of the year, it is advisable to discharge at as high a temperature as possible without decreasing the vacuum below the desired figure. However, where water is plentiful there is a tendency to use an excess to take care of maximum-load periods, thus producing a comparatively low discharge temperature.

Where the condensing apparatus is improperly designed to suit the given conditions it may be found necessary at times to operate at a much lower vacuum during the summer months than would be necessary if the condensers were properly selected.

The approximate quantity of condensing water required to condense one pound of steam with a jet condenser may be obtained from the following equation:

$$Q \times (T - t) = (H + 32) - T$$

where

Q = Pounds of water required to condense one pound of steam;

T = Temperature of discharge water, leaving the condenser, in degrees Fahrenheit;

t = Temperature of the injection water entering the condenser, in degrees Fahrenheit;

and

H = Total heat above 32 degrees Fahrenheit in one pound of steam to be condensed.

Transposing in the equation,

$$Q = \frac{(H + 32) - T}{(T - t)}$$

From the foregoing it is readily seen

that the quantity of water required depends chiefly upon its initial temperature, which may vary from, say, 40 degrees Fahrenheit during the winter months to 80 degrees or more during the summer months, depending upon the location of the plant and the source of water supply.

Table 2 is based on the new steam tables by Marks & Davis and is given here as a guide in figuring the condensing water required per pound of steam in condenser installations. In column 1 is given the vacuum in inches of mercury referred to a 30-inch barometer. Column 2 gives the corresponding absolute pressure in pounds per square inch, above vacuum. Column 3 contains the corresponding temperature of the mixture of steam and water at the condenser pressure and in column 4 is given the total heat in one pound of steam at the given pressure, to which has been added 32 B.t.u.

For example: With a vacuum of 28 inches of mercury referred to a 30-inch barometer ($H + 32$), is found from Table 2 to be 1137 B.t.u. Substituting in the formula,

$$Q = \frac{1137 - T}{T - t}$$

for a 28-inch vacuum. In column 5 the volume in cubic feet per pound of steam is given, and in column 6 the weight of one cubic foot of steam at the given pressure and temperature corresponding to the given vacuum.

In determining the proper value to substitute for T, the temperature of the discharge water, care should be taken to allow a suitable drop between the steam in the condenser and the temperature of the discharge water. In practice the temperature of the discharge water is assumed to be 15 degrees lower than the steam temperature and it is customary to allow for 10 per cent. more water than the estimated quantity where actual conditions are unknown.

TABLE 2. DATA FROM WHICH TO DETERMINE CONDENSING WATER REQUIRED PER POUND OF STEAM

Vacuum in Inches of Mercury Referred to a 30-inch Barometer	Absolute Pressure in Pounds per Square Inch	Temperature in Degrees Fahrenheit	(H+32) B.t.u.	Volume in Cubic Feet per Pound of Steam	Pounds of Steam per Cubic Foot
29.82	0.09	32	1105	3294	0.0003
29.50	0.25	59	1117	1249	0.0008
29.00	0.50	80	1127	636.8	0.0016
28.50	0.74	92	1132	442.2	0.0023
28.00	1.00	102	1137	331.5	0.0030
27.50	1.24	109	1140	272.9	0.0037
27.00	1.51	116	1143	225.8	0.0044
26.50	1.72	121	1145	197.9	0.0050
26.00	1.99	126	1147	173.9	0.0057
25.50	2.22	130	1149	157.1	0.0064
25.00	2.47	134	1150	142.2	0.0070
24.50	2.73	138	1152	128.9	0.0077
24.00	2.96	141	1153	119.9	0.0083
23.50	3.19	144	1155	111.6	0.0089
23.00	3.45	147	1156	104.0	0.0096
22.50	3.70	150	1157	97.0	0.0103
22.00	3.96	152	1158	93.0	0.0108
21.50	4.18	155	1159	86.4	0.0116
21.00	4.40	157	1160	82.6	0.0121
20.50	4.70	159	1161	78.0	0.0125
20.00	4.90	162	1162	73.8	0.0135
18.00	5.80	169	1165	63.3	0.0158
16.00	6.85	176	1168	54.5	0.0183
14.00	7.85	182	1171	48.12	0.0207
0.00	14.70	212	....	26.79	0.0373

Surface Condensers

When estimating the quantity of water required per pound of steam in surface condensers it is customary to take into account the temperature of the condensed steam; that is, the hotwell temperature.

Hence for surface condensers

$$Q = \frac{(H + 32) - T_c}{T - t}$$

where T_c equals the temperature of the condensed steam and Q, H, T and t represent the same quantities as in the formula for jet condensers. In the ordinary surface condenser of the single- or double-flow type, T_c may be taken from 10 to 20 degrees lower than the temperature due to the vacuum.

How the Engine Was Wrecked

By W. F. Burdick

On a recent morning, in the mill where the writer is employed as chief engineer, a center-crank engine, 15x16 inches, operating under 150 pounds pressure at a speed of 150 revolutions per minute, suddenly began to make strange noises at the head end of the cylinder. The engineer tried to locate the noise, but failed, and the pounding so increased that it jarred the engine severely.

As he was afraid to take any further chances, the engineer shut down. He thought that when the engine was stopped he could locate the cause of the pounding, but just as he closed the throttle valve the engine went to pieces. The frame and shaft governor were the only parts left intact.

The strap on the wristpin end of the connecting rod broke first (see *A*, Fig. 1), but it did not open enough at first to free the box and crosshead. As the clearance between the piston and cylinder head was only ⅜ inch, the opening of the strap allowed the piston to strike the cylinder head, thus causing the pounding.

Perhaps one minute elapsed from the time the pounding was noticed until the accident. Every time the engine took steam at the crank end the strap was opened wider until finally it broke loose and separated the piston rod and crosshead from the connecting rod, knocked out the cylinder head and broke off every stud which held the head to the cylinder.

The cylinder head was afterward found 28 feet away from the engine, and

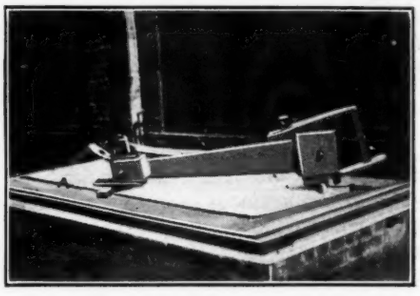


Fig. 1. Connecting Rod

as the piston was out of the cylinder about 6 inches it would have accompanied the head if the crosshead had not brought up against the opposite head. The spool pieces which supported the upper crosshead guides were also broken and the bolts were so badly bent and twisted as to be useless.

As the momentum of the machinery had kept the crank shaft moving, it threw the connecting rod to the front part of the frame. When in that position the counterbalance could not pass, and it

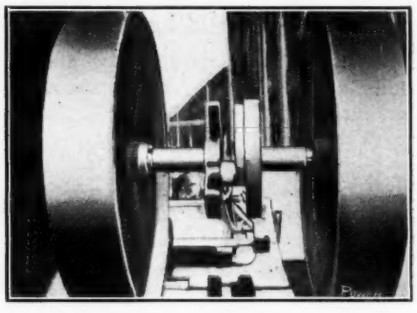


Fig. 2. Flywheels of Wrecked Engine

therefore broke off the straps of the crank-pin boxes and sheared off the bolts and key as well as the counterbalance (see Fig. 2).

Though the counterbalance weighed 460 pounds, it was found tightly wedged between the frame and the flywheel, one spoke of which was broken. The connecting rod was discovered in front of the engine, where it had fallen after breaking loose from the crank pin.

As this engine was placed out in the factory, with its cylinder head just clearing a passageway where the help were almost continuously passing to and fro, it was remarkable that no one was hurt. The engine only was damaged.

Using Compressed Air in Steam Hoists

By Frank Richards

At the Anaconda copper mines compressed air is used to drive 25 steam hoists with an aggregate capacity of 40,000 horsepower, although only 4000 horsepower is required in constant operation. A battery of air receivers in connection with an open water tank afford storage capacity and keep the pressure constant.

One of the most unsatisfactory features of compressed-air practice up to the present time has been in the inadequacy of the means provided for storing the air between its compression and its use, or for maintaining a full and constant pressure under a varying rate of consumption. It may be said that compressed air wherever employed, is always used more or less intermittently, and never at any constant rate except in cases where the entire output of a compressor of a large compressing plant is employed in a single water-pumping operation.

The air receiver usually provided with an air compressor has a total air capacity not exceeding the output of the compressor for a single minute, so that if the compressor stops or is slowed down to below the capacity to supply the consumption the pressure instantly begins to fall. To insure somewhat reliable maintenance of pressure and volume it is the practice to provide a maximum compressing capacity somewhat in excess of the maximum demand and then to automatically reduce the speed of the compressor as the rate of consumption diminishes. Even this arrangement usually does not completely satisfy the fluctuating requirements, and so we have various unloading or choking contrivances which will still more reduce the output without actually stopping the machine. However satisfactory the results thus obtained may be, it is evident that they are secured only by more or less complication of apparatus and a sacrifice of the essential conditions of power economy in the running of the machine.

A magnificent opportunity for the solution of this air-power storage problem opened to the engineers of the Anaconda Copper Mining Company, at Butte, Mont., when it was proposed to find a cheaper means of driving their great mine hoists than by the use of steam. There were at Butte 25 large steam-driven hoists with an aggregate capacity of 40,000 horsepower, but the service required of the hoists was so intermittent, and the actual time of working of each was so short, that it was estimated that 4000 horsepower in constant operation would be sufficient for all the requirements, but it was imperative that the power should be always ready and always sufficient for each individual hoist.

The cost of steam had been about $80 per horsepower per year, while electric horsepower per year could be had for about $25. There were, however, serious objections to the adoption of the electric drive for each separate hoist, besides the enormous first cost of such an installation. Here, also, there could be no power storage, so that it would be necessary at times to have current available for nearly all the hoists at once.

So far as the steam hoisting engines were concerned, they could be adapted to the using of compressed air at comparatively slight cost, if only the power-storage problem could be solved, so that a constant drive of sufficient average capacity could be made able to take care of the peak loads whenever they should occur, even up to the running of all the hoists at once. The problem has been solved with a success and completeness seldom surpassed in great engineering undertakings.

The electric current which drives the compressors is transmitted 130 miles from the new plant of the Great Falls Water Power and Townsite Company, at Rainbow falls, just below the Great falls on the Missouri river. There are three compressors, each with a direct-connected Westinghouse motor of 1500 maximum horsepower. The compressors, furnished by the Nordberg Manufacturing Company, are two-stage machines of the highest class, with low-pressure cylinders 50 inches diameter and high-pressure cylinders 30 inches diameter, and a common stroke of 48 inches. The combined free-air capacity of the three compressors I would estimate roughly at 20,000 cubic feet per minute (not knowing the builder's specifications as to speed, etc.).

The Air Receivers

From the compressors the air passes to the battery of air receivers. There are 32 of these, vertical, each 10 feet diameter and 30 feet high, their combined cubical content being, say, 70,000 cubic feet, which, at 90 pounds gage pressure, may be said to equal 500,000 cubic feet of free air, a volume which it would take the combined compressors nearly half an hour to compress and deliver. This is very different, to begin with, from the less than one minute capacity of the air receiver usually provided.

But the more important particular is that whereas in the established and familiar air-receiver practice, as soon as any air is withdrawn from the receiver in excess of what the compressor is delivering, or if for any reason the compressor stops, the pressure in the receiver begins to fall rapidly and constantly with the drawing of the air, it is as different as can be under the arrangement here being considered. Instead of a drop of pressure rendering the remaining contents of the receiver ineffective and useless, the pressure is maintained and the entire contents of the whole battery of receivers, including the original inert filling of air at atmospheric pressure, can be used at full pressure and effectiveness until the receivers are emptied. In practice the withdrawal of the air never goes as far as this. As these compressors run all day and all night, when there is at any time a simultaneous call for operating an unusual number of hoists, there is always the full capacity of the working compressors and also the entire contents of the battery of receivers to draw from until the unusual and excessive demand for air ceases. When there is such an unusual simultaneity of hoisting it is necessarily succeeded by a period when the hoisting and the demand for air are less than the compressor output, and then the receivers are automatically filled again.

How the Air Pressure Is Maintained

The device by which the air pressure is maintained in the receivers notwithstanding the diminution of the contained air is essentially a simple one. It is accomplished by the use of a standpipe or its equivalent, the same as in waterworks service. On a side hill at an elevation sufficient to give the required gage pressure of 90 pounds, there is an open water tank 100 feet in diameter and 15 feet deep. A depth of 10 feet in this tank gives a water capacity somewhat greater than the total cubic capacity of the battery of air receivers. As 2.3 feet of water gives 1 pound pressure, the mean elevation of the tank above the receivers should be

$$90 \times 2.3 = 207 \textit{ feet.}$$

There is a large pipe connection from the bottom of this tank to a horizontal pipe in free communication with the lower ends of all the receivers. No valves of any kind are required, and little, if anything, need be allowed for the friction of the water in the pipes, it being free to flow in either direction, according to the changes of the volume of air in the receivers. No safety valves are required, and it is impossible to produce any pressure in the

receivers greater than that due to the head of water.

The compressed air as it is delivered from the operating compressors does not pass through the receivers, and, indeed, does not enter them at all except when the air production is greater than the consumption at the moment, when the surplus passes into the receivers, driving out and up into the elevated tank some of the water at the bottom of the receivers. When the call for air is greater than the compressor supply then the deficiency is made up by a flow of air from the receivers, the water from the tank displacing it.

The contact of the air with the water does not make it any wetter, as after compression it is quite certain to be saturated with water in any case. In the service for which this air is used, there is no call for "dry" air, as special means are provided for heating the air before it enters the hoisting engines, and moisture would be an advantage rather than otherwise.

The plant is unique as it stands, but in the use of the elevated tank it sets an example which in time should be widely adopted. For the maintenance of a constant air pressure with considerable storage capacity it seems to recognize and fill a long persisting requirement. The elevations which will give gage pressures of 50, 60, 70, 80, 90 and 100 pounds are, respectively, 115, 138, 161, 184, 207 and 230 feet. These hights can, of course, be secured as well by sinking the receivers as by elevating the tanks, or by a combination of both until the vertical difference is secured.

Centrifugal Force and Flywheels

By H. D. Odell

While it would be a hard matter to get a majority of operating engineers to "acknowledge the corn," there is no doubt in my mind that a goodly percentage of flywheel explosions are caused by ignorance on the part of the engineer in not knowing how to find the safe speed for a given wheel. To increase the working capacity of his engines many a man will increase the speed, taking chances on the flywheel standing the extra strain. In some cases this is like putting the extra straw on the proverbial camel's back. I have known of instances where second-hand engines were bought to pull generators (direct connected) where the speed of the generators was greater than the speed of the engines; the engineers would say, "Guess they'll stand it," and go ahead and speed them up, never figuring on the bursting speed of the flywheel.

I know of one case where the manager of a company bought a generator in one place and the engine in another. That he had some common sense is shown by the fact that after contracting for a certain type, he made arrangements with the engine builders to have the armature of the generator brought to their shop and pressed on the engine shaft. The capacity of the engine was exactly right for the generator; he was particular to see that no mistake was made in the size of the shaft, in order that the armature would fit. And he was particular to make sure that the space between the main bearings was sufficient to accommodate the generator. But he never once thought of the speed of the generator, and the result was that the machinery was placed and ready to run before the oversight was noticed. Rather than acknowledge his mistake to headquarters the manager gave the engineer orders to increase the speed of the engine 25 revolutions per minute. As far as I know, nothing serious ever happened, but it was not due to good judgment on his part.

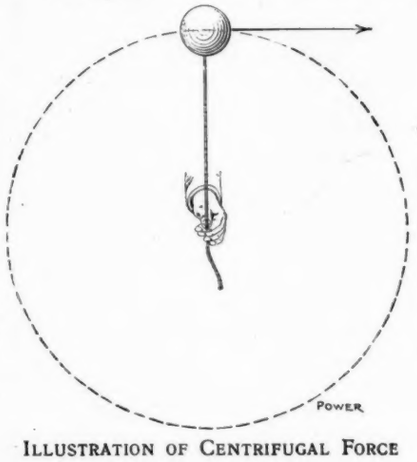


Illustration of Centrifugal Force

The foregoing serves to illustrate the importance of realizing the influence of centrifugal force and being able to calculate the safe speed for a given flywheel.

If a body is fastened to a string and whirled so as to receive a circular motion, there will be a pull on the string which will be greater or less as the velocity increases or decreases. Assume that the body is revolved horizontally, so that the action of gravity on it will always be the same. According to the first law of motion, a body put in motion tends to move in a straight line unless acted on by some other force, causing a change in direction. When the body moves in a circle, the force that causes it to thus move instead of in a straight line is exactly equal to the tension of the string. If the string were cut, the pulling force that drew it away from the straight line would be removed, and the body would then move in a straight line tangent to the circle, as in the accompanying figure. Since, according to the third law of motion, every action has an equal and opposite reaction, the force that acts as an equal and opposite force to the pull of the string is called the "centrifugal force" and it acts away from the center of motion. The other force, or tension, of the string is called the "centripetal force," and it acts toward the center of motion. It is evident that these two forces, acting in opposite directions, tend to pull the string apart, and, if the velocity be sufficiently increased, the string will break. It is also evident that no body can revolve without generating centrifugal force.

The value of the centrifugal force, expressed in pounds, of any revolving body is calculated by the following rule: The centrifugal force equals the continued product of 0.00034, the weight of the body in pounds, the radius in feet (taken as the distance between the center of gravity of the body and the center about which it revolves), and the square of the number of revolutions per minute. Let

F = Centrifugal force in pounds;
W = Weight of revolving body in pounds;
R = Radius in feet of circle described by center of gravity of revolving body;
N = Revolutions per minute of revolving body.

Then,

$$F = 0.00034\ W\ R\ N^2$$

For example, we will say that the string in the accompanying figure is 5 feet long. If the ball weighs 5 pounds and is revolved at the rate of 500 revolutions per minute, what will be the tension in the string? Using the rule just given,

$$F = 0.00034 \times 5 \times 5 \times 500^2 = 2125 \textit{ pounds}$$

In flywheels, belt wheels and pulleys the centrifugal force tends to tear the rim asunder. This tendency is resisted by the tenacity of the material of which the wheel is composed. Since the centrifugal force increases as the square of the number of revolutions, it will be seen that an apparently slight increase in the number of revolutions per minute may be sufficient to burst the wheel. For solid cast-iron wheels and for built-up wheels of cast iron where the strength of the joint is equal to the strength of the rim, the greatest number of revolutions per minute that practice has indicated to be safe may be found by the following rule: Divide 1930 by the diameter of the wheel in feet. Thus

$$N = \frac{1930}{d}$$

where d equals the diameter of the wheel in feet and N equals the number of revolutions per minute. For example, for a cast-iron flywheel 25 feet in diameter, what would be the maximum number of revolutions allowable? Using the rule just given, we have

$$N = \frac{1930}{25} = 77 \textit{ revolutions per minute.}$$

Why Central Stations Catch Isolated Plant Business

By Henry D. Jackson

That the central station has been able in the past, and will be able in the future, to get much of the isolated-plant business, is not hard to understand if one takes time to investigate. In the first place, the sales agent of a central station is a trained engineer. He knows not only the cost of producing power in his own plant, but also what the average manufacturing plant is paying for it; his training and experience in gathering information from the isolated plant enable him to place before the owner or manager of the isolated plant, figures showing what it costs them to produce power, and unfortunately he is also able to add unnecessary figures to these costs which will make them very much higher without fear of their being contradicted in most cases. Owing to his presence, his training and the lack of knowledge on the part of the manufacturer, the central-station agent can usually get a hearing, and will frequently make such a favorable impression that his figures are swallowed whole.

On the other hand, the engineer of the isolated plant is frequently looked upon by the manufacturer as a necessary evil, his sole duty being to keep the plant in operation. He is not expected to make a careful and accurate report of what his boilers and engines are doing or what the machinery requires in the way of power; so long as he keeps the plant moving he is considered to have done his duty. This is an unfortunate condition. No manufacturer would consider hiring a man as the head of his department who could not give him accurate figures regarding the cost of all material and labor in his department, and, in general, the entire manufacturing cost, that the manufacturer may know whether this department is showing results.

The power plant is as important a part of the business as any other, and the engineer should be the manager of this department and be able to deliver to the owner such a report as is delivered by the head of any other department. He should be trained to keep an accurate record of everything entering the power plant and its operations, these reports to be in such form that the owner at any time may determine what the cost of power might be from day to day, week to week, month to month, and year by year. Interest, maintenance and depreciation should be charged off against the plant, and a careful record kept of everything entering into the cost of power.

To do this requires that the engineer be more than a mere engine-runner. It requires that the plant be fitted with apparatus necessary for weighing the coal, measuring the water, keeping track of the oil, waste, general supplies, repair parts, etc. The engineer should be provided with indicators and all that is necessary to determine the amount of power required in various parts of the factory; if the plant be equipped for electric drive, recording wattmeters should be installed. Report blanks should be provided for the engineer, and daily reports should be rendered to the clerical department giving the condition of the boilers, the number of boilers in service, the amount of coal fired, the character of the coal, the amount of water evaporated, the labor costs and supplies used; in short, the information which would enable the manufacturer at any time to compare his power costs.

In many plants where apparatus is so arranged that the engineers could keep such records, the salaries are so low that an engineer capable of keeping these records will not accept the position. The lesson is plain; men should be employed who are capable, and they should be paid enough to warrant their getting satisfactory results. They should be paid in proportion to the value of their services, as is any other department head. Demand records from them which are of service, and rely upon these records. When this is done the central-station agent will have hard work to prove that he can supply power at a price that is comparable with a properly run isolated plant.

As it is now, the central-station solicitor can give cost figures for the operation of the isolated plant that are manifestly absurd to those who are trained in power-generation matters, and the only recourse isolated-plant owners have is to refer such matters to a consulting engineer, and rely upon his judgment. To depend upon the central-station man for such figures is unwise as he is unavoidably prejudiced, and frequently worse than that. The isolated-plant owner should take the same ground here that he takes in the purchase of any other of his supplies. When he purchases goods for his business, if the concern is large enough, he employs a purchasing agent to see that he gets what he pays for. Materials are submitted to his department head, who is a trained specialist, and he reports as to whether the goods are suited to the purposes. As a rule, he knows nothing about prices, as he is simply a judge of the materials offered. This report then goes to the purchasing agent, who compares it with the cost of the materials and purchases those materials which for the price will give the best results.

The power plant should be handled in exactly the same way. The study of a number of power plants shows that this is not done in very many cases, even in large establishments. Coal is often purchased at the lowest price, regardless of its heat-unit value, and materials are usually bought regardless of whether they will properly serve their purpose. Coal should be purchased on the heat-unit basis, or on the basis of that coal which will evaporate the largest amount of water per unit of cost, and supplies should be purchased on the basis of that price which will result in the lowest cost.

Until some such method of handling the power plant is devised, the power department will continue to be operated at an excessive cost, and the central-station agent will continue to have an excellent opportunity for securing business which otherwise would be unobtainable.

Oil in Wyoming

The United States Geological Survey has just issued, as Bulletin 452, a report on "The Lander and Salt Creek Oil Fields, Wyoming," by E. G. Woodruff and C. H. Wegemann.

Practically all the development in the Lander field, says Mr. Woodruff, has been confined to the southeastern district, along Little Popo Agie river in the vicinity of Dallas. The history of this oilfield is far more interesting than that of any other in Wyoming, for here Bonneville discovered oil in 1833. From the date of his visit to 1867 the oil spring was unknown except to hunters and trappers who frequented the locality to procure the oil for medicinal purposes. In 1883 and 1884 three oil wells were drilled, all of which were productive, but on account of keen competition from the Eastern oil producers the first Wyoming oil company had to abandon its enterprise. For some time the wells remained packed, but the oil that flowed from the wells through leaks was utilized to some extent by the ranchers for miles around as a lubricant and by the gold mines and flour mills for steam making. Recently operations at the wells have been resumed on a more extensive scale.

The oil is adapted to several uses. It forms an excellent fuel, comparing favorably with the Texas or California oils, and is now employed for that purpose in practically all the development work in the Little Popo Agie district. Some of it can be used in its raw state as a lubricant, though in general it is not suitable for that purpose. As the oil contains a heavy asphalt base, it is good for oiling roads.

Perhaps one of the most interesting wells in the Salt Creek oilfield is one drilled in 1910 which struck oil under pressure in shale at a depth of 1176 feet. This well yielded an unusually large amount of oil for a shale well. Oil travels much more slowly through shale than through sandstone, and where large quantities are produced from shale a slight crevice or fissure is generally present. This fissure may be a fraction of an inch in width and yet be of sufficient extent to contain large quantities of oil and to allow the oil to reach the well rapidly.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment

Power Development on the Los Angeles Aqueduct

By LeRoy W. Allison

In connection with its aqueduct project, Los Angeles, Cal., is afforded an exceptional opportunity for the development of electrical power. This aqueduct undertaking is a notable example of municipal enterprise; Los Angeles, with a population of a little over 300,000, shows implicit confidence in its future by incurring a bonded debt for this work which will ultimately total about $30,000,000.

A few features of the topography of the aqueduct route, shown in Fig. 1, and of its construction, will aid in understanding a general description of the plans for hydroelectric development. Owens river, the source, about 240 miles from Los Angeles, is fed from the mountains of the Sierra Nevada range, which form the eastern boundary of the Yosemite National Park. It flows southerly through the valley formed by these mountains and the White and Coso ranges, emptying into Owens lake, in Inyo county, about 100 miles from its rise. This lake covers an area of about 175 square miles and has no surface outlet. Except for a distance of approximately 60 miles of mountainous territory, the route of the aqueduct lays through the Mojave desert, offering many difficulties to construction work of this character. For the first 20 miles, the aqueduct is a canal about 50 feet wide and 10 feet deep; then it is in the form of covered and uncovered conduit, tunnels through mountain rock and steel siphons, as the natural conditions require.

Mountain water, at the rate of 260 million gallons net per 24 hours, will be delivered to the city by means of reservoirs situated in the San Fernando valley, about 20 miles distant. Including reservoirs to be placed along the route for the conservation of the supply, the capacity of this impounding system will be about 376 million gallons. The elevation at the aqueduct intake is 3812 feet, at the reservoirs in the San Fernando valley about 1165 feet, while the average in Los Angeles city is close to 300 feet. Hence, the system throughout will be one of gravity flow, eliminating any expense for pumping machinery and affording greater simplicity of operation as well as reduced maintenance cost. It is expected that the aqueduct will be in service by December, 1912.

Development

The feasibility of developing electric power in conjunction with the aqueduct was reported upon by a consulting board

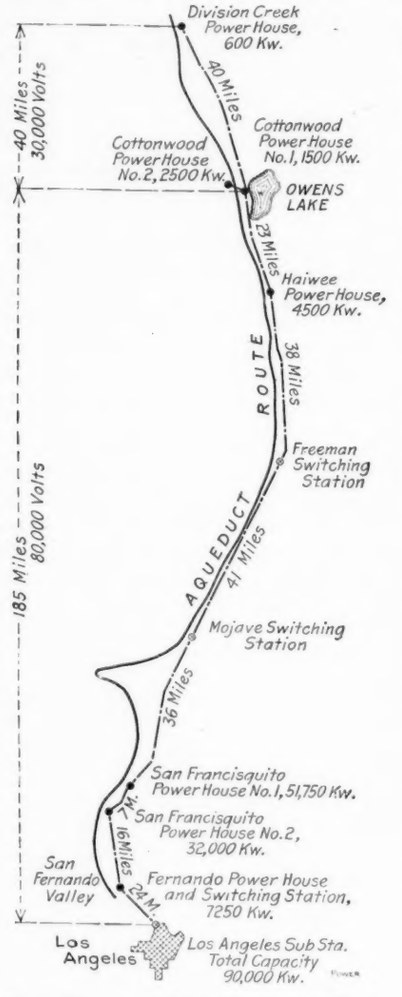

Division Creek Power House, 600 Kw.
40 Miles
40 Miles — 30,000 Volts
Cottonwood Power House No. 2, 2500 Kw.
Cottonwood Power House No. 1, 1500 Kw.
OWENS LAKE
23 Miles
Haiwee Power House, 4500 Kw.
38 Miles
ROUTE
Freeman Switching Station
185 Miles — 80,000 Volts
AQUEDUCT
41 Miles
Mojave Switching Station
36 Miles
San Francisquito Power House No. 1, 51,750 Kw.
San Francisquito Power House No. 2, 32,000 Kw.
16 Miles
San Fernando Valley
24 Miles
Fernando Power House and Switching Station, 7250 Kw.
Los Angeles
Los Angeles Sub Sta. Total Capacity 90,000 Kw.

Fig. 1. Route of Aqueduct and Transmission Line

of three experts, Prof. W. F. Durand and Prof. H. J. Ryan, both of Leland Stanford University, and O. H. Ensign, of the U. S. Reclamation Service.

The available head of water above San Fernando valley is 3812 less 1165, or an approximate total of 2647 feet; this is estimated to afford a total generating capacity of 48,000 kilowatts. The location of power plants, switching stations and transmissions lines along the aqueduct is shown in the accompanying diagram, Fig. 1. Division Creek power house of 600 kilowatts capacity and Cottonwood plant No. 1 of 1500 kilowatts have been completed and put into commission, taking water from two of the mountain streams near the aqueduct intake. Transmission lines have been strung for a distance of about 150 miles, making power available for construction purposes and for lighting the town of Independence, in Inyo county. Cottonwood power house No. 2, of 2500 kilowatts capacity, is now being built, and the four other stations will be constructed as rapidly as possible, making a total of seven generating plants, with the respective rated capacities noted on the diagram. The ratings are based on an average aqueduct flow of about 400 cubic feet per second, a flow at the Division Creek plant of 8 cubic feet per second, and a rate at the Cottonwood sites of 20 cubic feet per second.

In the San Francisquito cañon, about 40 miles from Los Angeles, one of the finest points in the course is offered for power development by a "step" in the aqueduct grade of 1500 feet. At this site the two largest plants will be erected. They will be provided with storage reservoir facilities for impounding, so that power can be generated as needed. This power will be available in two large blocks, of about three-fourths of the capacity output, giving a maximum peak delivery at the Los Angeles substation of approximately 90,000 kilowatts. The reservoirs will serve to prevent interruption of service through any failure in the aqueduct north of the cañon, and are also expected to eliminate the usual drawbacks to hydroelectric development, such as irregularity of stream flow due to annual low-water period, the effect of seasonal changes, etc., thereby making auxiliary steam equipment unnecessary. Another excellent feature is the proximity of the main plants to the central distributing station in the city, a distance of only 40 miles; this will permit of ready repairs and improvements to the generating plants.

Steel pipe and concrete tunnels will be used for such sections of the line as are under pressure, fully protected by safety

relief valves and regulating devices to prevent rupture from shock.

The transmission lines will be carried on steel towers, and the first 40 miles, between Division Creek and Cottonwood, will be operated at 30,000 volts; for the remaining 185 miles, the potential will be increased to 80,000 volts.

The initial cost of this development is unusually low, being from $60 to $80 per kilowatt, delivered at the city station. From tables compiled by the Ontario Hydroelectric Power Company, such developments range from $67 to over $200 per kilowatt.

Utilization of the Power

It is natural that the three large power companies now established in Los Angeles and vicinity do not regard this municipal enterprise with particular favor. These organizations have invested many millions in properties; they employ a large number of residents, and they pay close to $1000 a day in city and county taxes.

Inclusive of power for all purposes, the average city peak load may be estimated at 36,000 kilowatts, a 24-hour period giving an average load curve about as shown in Fig 2. Including neighboring communities, the peak demand is approximately 58,000 kilowatts.

One of the most important problems confronting the consolidation commission of the city, a board organized to consider the water and power question, was the distribution of the power to be available. Some of the city officials were in favor of disposing of the power to private companies in blocks for a certain term of years at a price offering a fair rate of profit on the investment, with an equitable charge to consumers. This would save the city the expense of a distribution system and afford a period in which to replenish its resources.

Accordingly the power companies were invited to present a proposal to be placed before the people at a coming election, a two-thirds vote being necessary for the ratification of any such sale. The power companies, however, claiming insufficient time to make an intelligent estimate, failed to submit a positive proposition. A tentative proposal was suggested at one of the conferences, based on a lease of about 15 years, to pay the city $35 per kilowatt-year at the switchboard, if the rate to the consumers remained as now, 7 cents; or $30 if the consumers' rate became 6 cents, or $25, if 5 cents. The highest rate would net the city $480,000 a year, but E. F. Scattergood, chief engineer of the city power bureau, replied that the city could make a net annual profit of $700,000 by charging the same rate (7 cents), using but one-sixth of the total power generated; an excess of $220,000 more than offered, and leaving five-sixths of the power still to be sold.

At the election in March, 1911, a so called "straw vote" was taken on the two propositions: (1) Shall the city distribute directly to its inhabitants the electricity to be generated by it on the Los Angeles aqueduct, or (2) shall the city sell to the lighting companies for a term of years the electricity to be so generated. The former proposition was carried by a vote of ten to one.

It is estimated that a distributing system capable of reaching all consumers within the present city limits, an area of 100 square miles, and serving the street lighting (now costing the city $21,000 a month), can be installed for about $4,500,000, exclusive of any railway service, which is governed by private interests.

As provided for in recent city-charter amendments, a Power and Light Bureau will be organized, having under its jurisdiction all features of the work, including city distribution. E. F. Scattergood, chief electrical engineer of the aqueduct and head of the present power bureau, will be in charge.

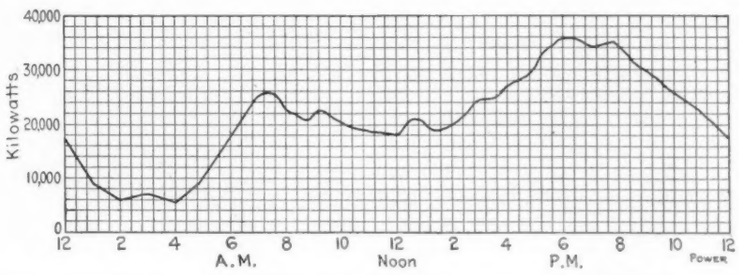
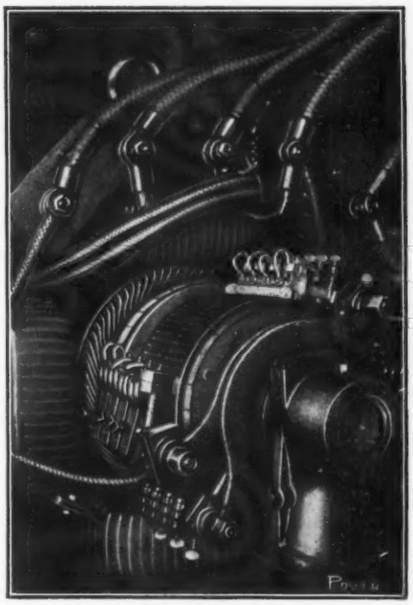


Fig. 2. An Average Load Curve for Los Angeles

A Novel Commutator Lubricant

By L. M. Johnson

Having had a great deal of trouble and annoyance with direct-current commutators and brushes becoming dry and scratching, I experimented with numerous methods of lubricating the brushes, but with very little success. One day, when I happened to have in my hand a piece of flax rod packing, I stopped to look at a large motor that was making a great deal of noise from the brushes scratching; remembering that flax packing contains a large amount of oil, it occurred to me to try rubbing the packing against the commutator. Upon doing so I was surprised to note that the commutator at once brightened up and that the brushes stopped scratching. I then cut a piece of square flax packing the length of the commutator face and laid it on the commutator in front of the brushes so that the rotation of the commutator would crowd the packing against the brush holders, as shown in the accompanying picture.



A Novel Commutator Lubricant

After a day's run the packing was taken off for examination, and it was found that the side next to the commutator was quite smooth and coated with fine copper dust and dirt that it had collected from the commutator. This treatment was then applied to other motors and generators, and after a trial over a number of months it has proved very satisfactory both in keeping the commutator clean and making the brushes run quiet. The commutators of two heavy-duty motors, which it was formerly necessary to sandpaper every morning, do not now have to be sandpapered oftener than about once a week.

The packing should bear on the commutator heavily enough to collect all dust and dirt and it should be turned over every day or so until all four sides have been used; then a new piece should be put on.

Several power-supply undertakings are now operating successfully at 110,000 volts, and a few 140,000-volt lines are projected. A voltage of 200,000 is considered to be within the region of practicability; in fact, it is now regarded as much more practicable than was one of 100,000 volts a decade ago.

Gas Power Department

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men

The Remington Kerosene Engine

A very simple form of internal-combustion engine intended to burn kerosene has been brought out by The Remington Oil Engine Company, Stamford, Conn., and is illustrated by the accompanying engravings.

The engine is of the automatic-ignition type—that is, the charge is ignited without the use of auxiliary devices—

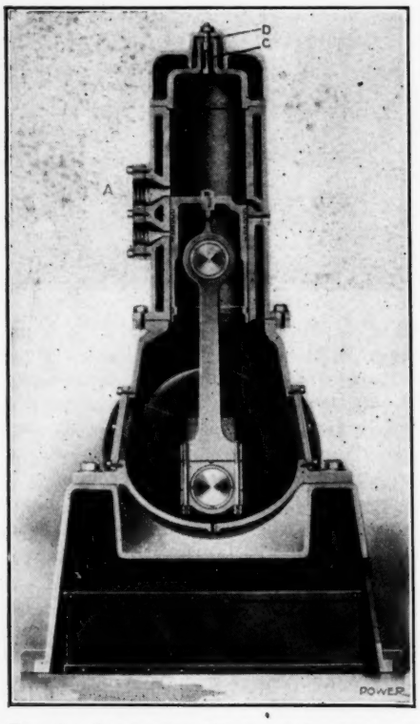


FIG. 1. SECTIONAL VIEW OF REMINGTON ENGINE, ALSO SHOWING PORTS

and operates on the two-stroke cycle. Ignition of the fuel is caused by a nickel-steel rod *C*, which is located in a circular pocket in the cylinder head and retains sufficient heat from each combustion to enable the heat in the air compressed on the succeeding upstroke to raise its temperature above the igniting point of the fuel. The cylinder head is hooded to conserve the heat developed in the combustion chamber and also to provide a sort of heater for starting.

The control of the air and products of combustion is effected by means of ports in the cylinder wall which are covered and uncovered by the piston, as is common with practically all small engines working on the two-stroke cycle. With the piston at the bottom of its stroke, as shown in Fig. 1, the exhaust port *A* and the inlet port on the opposite side of the cylinder are uncovered and air which has been compressed in the crank case rushes through the transfer passage and inlet port into the cylinder, expediting the exit of burned gases through the exhaust port *A*. When the piston is pushed up by the momentum of the flywheel, the air in the cylinder is compressed to about 125 pounds, gage, and thereby heated, of course. The heat of compression restores the temperature of the ignition rod *C*, which has been lowered during the expansion stroke, and as the piston reaches the upper end of the compression stroke, a small pump delivers a spray of kerosene through the nozzle shown in Fig. 2 against the end of the ignition rod. The charge is thereby ignited, combustion being supported by the air previously compressed in the cylinder, and the hot gases expand and force the piston down, in the well known manner. At the end of the downstroke the exhaust and inlet ports are uncovered, releasing the burned gases and admitting air from the crank case again, starting another cycle.

When the piston travels upward, a partial vacuum is formed in the crank case, which is entirely closed in as soon as the piston covers the port at the end of the transfer passage. When the piston reaches the end of the upstroke it uncovers the port shown beneath the exhaust port *A*. This third port admits air to the crank case, the atmospheric pressure forcing the air in to "fill up" the vacuum there. When the piston descends again, the air just admitted to the crank case is compressed to about 5 pounds above atmospheric, so that when the inlet port is uncovered by the piston the pressure in the crank case drives air into the cylinder.

The quantity of air taken into the cylinder is the same for every stroke, no matter what the load may be. The quantity of fuel oil delivered to the spray nozzle is varied by a centrifugal governor which controls the stroke of the kerosene pump. The governor consists of an L-shaped weight *E*, Fig. 2, pivoted to an arm of the flywheel at *F* and provided with an extension finger at its free end; this finger shifts a cam *G* along the shaft. This cam actuates the pump plunger and the stroke of the plunger depends on the position of the cam along the main shaft; when the cam is moved inward, toward the crank case, the pump stroke is shortened, thereby reducing the quantity of kerosene delivered to the spray nozzle. Centrifugal force in the governor weight tends to move the cam inward and a helical spring opposes this effort.

The long lever *J*, pivoted to the bracket *H*, is used to control the maximum speed of the engine by hand and to shut it down. The lower end of the lever engages the cam *G* and determines the point to which the governor spring can pull the cam outward, and thereby the maximum possible travel of the kerosene-pump plunger. When the handle of the lever *J* is pulled out as far as it will go, the pump is put out of action and the

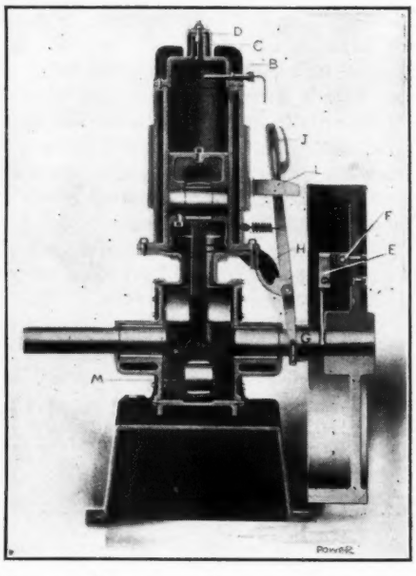


FIG. 2. SECTIONAL VIEW OF REMINGTON ENGINE, ALSO SHOWING GOVERNOR MECHANISM

fuel supply is therefore cut off, stopping the engine. This is necessary because the ignition is automatic and cannot be shut off.

To start the engine, the hollow hood on the cylinder head is heated by a kerosene torch furnished with the engine. When it is hot, a single charge of oil

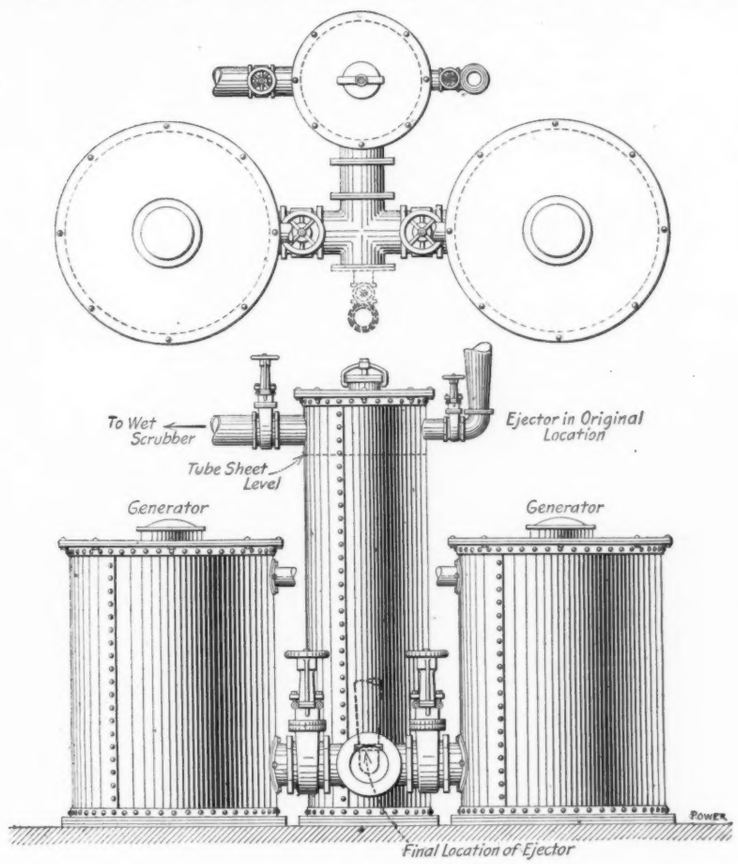
is injected into the cylinder by working the hand lever connected with the pump; the flywheel is then pulled smartly backward, thereby compressing the charge, which ignites before the piston reaches the highest point, and starts the engine in the forward direction.

Preventing Boiler Corrosion in Bituminous Gas Producer Plants

By C. B. Geoffrey

In operating a bituminous coal-gas producer of the down-draft type a great deal of trouble is experienced in most cases through deterioration of the waste-heat boiler.

In an equipment under the writer's supervision the boiler trouble was so serious that it was about decided to tear out the water space, line up the shell and supply steam for water-gas runs and the exhauster engine from a hand-fired boiler, at considerable expense for boiler equipment, added labor and continuous loss from nonrecovery of the sensible heat of the gas.



Arrangement of Generators and Boiler

The arrangement of the apparatus consisted of duplicate generating sets, each including two generators and a waste-heat boiler, arranged as shown in the accompanying sketch; only one set of scrubbers and one exhauster were arranged to take care of both generating sets.

For starting a new fire, a steam ejector was provided, as shown, above the top tube sheet of the boiler, which drew the gas through the latter while starting up. Before cutting in on the line this ejector was closed off and the main gas valve opened into the scrubber.

A new set of tubes had just been installed and the usual test indicated no leaks. The fires were started as usual, but before cutting in on the line the manhole cover was removed from the top of the gas space above the tube sheet and everything was found to be thoroughly wet; water completely covered the top tube sheet to the hight of the beading on the tube ends and was running down the tubes. The strong smell of ammonia and knowledge of the perfect job of retubing which had just been tested indicated that the water or liquid had been precipitated from the gases of combustion being rapidly cooled in contact with the cold boiler tubes; and as the velocity of the gases was considerably reduced in the large space above the tubes they had been apparently creating an artificial rainstorn. It was further observed upon opening the cleaning door at the bottom that an inch or so of this fluid had collected in the bottom space.

I endeavored to remedy this condition by filling the boiler with hot water through an injector before starting the fire, and this improved conditions to some extent. The chief improvement, however, was accomplished by removing the ejector from the scrubber end of the boiler and applying it on the bottom gas connection between the generators. Afterward, upon starting new fires the gases were not passed through the boiler until the fire beds were at their normal high temperatures; under these conditions and by treating the boiler to warm water initially no further trouble was experienced than would have been with an ordinary hand-fired boiler.

In cutting in a producer with this arrangement it is particularly advisable to open the purge valve for a moment before allowing gas to go to the holder, as a considerable volume of air may be entrapped in the boiler space and piping which should be blown out, especially when a holder of small capacity is used.

Coal in California

California's production of coal in 1910 was 11,164 short tons, with a spot value of $18,336, according to E. W. Parker, of the United States Geological Survey. In 1909, California showed the largest percentage of increase among the coal-producing States, and in 1910 the largest percentage of decrease.

From January to September of that year the Stone Cañon mines had produced 75 per cent. of the State's output for the entire year. No coal was produced at this mine in 1910 and the production decreased about 75 per cent. All of the lignite coal produced in 1910 came from Amador and Riverside counties, principally from the Ione mine in Amador county. The Stone Cañon coal is a non-coking bituminous coal of good quality and should make an excellent domestic fuel. It stands exposure well and with favorable freight rates would compete successfully with foreign coals in the markets of San Francisco and other cities of the State.

LETTER

Gasolene in the Lubricating Oil

A 30-horsepower two-cylinder marine engine working on the two-stroke cycle gave trouble very soon after its installation, the trouble being that the wrist brasses became hot and cut very rapidly. It was discovered that the heating was caused by gasolene in an unvaporized state getting into the crank case and washing the bearings clean of oil.

Steam-engine cylinder oil was tried as a last resort and it proved very effective; just enough gasolene got into the case to thin the oil to about the right degree for lubrication.

Lloyd V. Beets.

Nashville, Tenn.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words wanted

Kerosene Oil a Protection to Pipes and Pumps

Those having charge of pumps in and around mines will find that if they place a kerosene drip on the suction pipe they will have no more trouble with the pipe corroding and will also save the pump from the grit and sulphur water. Tap the suction pipe close to the sump for a ¼-inch pipe and valve. Then bush it up to 2½ inches and place a piece of 2½-inch pipe 2 feet long on it, or a pipe according to the size of the suction. I use 1 gallon every 10 hours for a 6-inch suction pipe. I find that in using kerosene I can prolong the life of the pumps and pipe about three times as long as when no oil is used.

L. B. Scott.

Clarksburg, W. Va.

Erecting a Steel Stack

The stack to be erected was 127 feet high, 66 inches in diameter and was built to supply draft to two 300-horsepower water-tube boilers. It could not be hoisted into place without being cut up into sections because the boiler house was completed and hemmed in on three sides by three buildings and on the other side by a mass of telephone and telegraph wires, and three lines of railroad.

The stack was shipped in three 30-foot and one 15-foot breeching sections. The first thing done was to place the breeching over the boilers; this was a comparatively easy matter. The first section was then cut into 5-foot lengths and sent up one at a time by block, tackle and a gin pole, without very much trouble. The limit of the gin pole was then reached and other means had to be provided.

It was decided to cut the other two 30-foot sections into 5-foot lengths and then cut those in half to enable the work to be carried on around the pole and tackle.

Starting inside the breeching, a scaffold was built; a length of 2x4-inch timber was placed vertically in the center of the stack and crosspieces of the same dimensions were cut to make a snug fit against the side of the stack. These were then spiked to the vertical timbers and made a very strong scaffold. Cleats were then nailed to the vertical timber to aid the workmen in going up and down the stack.

A 12-foot section of 2½-inch pipe was then bolted to the upper section of the stack by means of 3½-inch bolts, three rivets having been left out for the purpose. An eyebolt was placed at the upper end of the pipe, to which was fastened the block and tackle.

A half section of the stack was then hoisted and bolted temporarily in place until the next section was hoisted, when they were riveted together. The pole was then raised to the section just erected and the same operation repeated, the scaffold, of course, being added to as the sections went up.

The riveter's stage was made of 1½-inch angle iron and 1x6-inch oak boards, the top of the stage being supplied with a grooved wheel which enabled the riveter to swing around the stack.

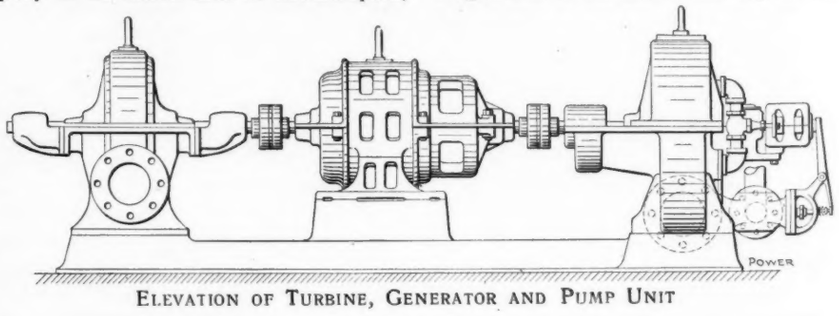
One would think that this was a slow method of erecting a stack, but the whole operation took only seven working days, including the riveting, and half the time the men were nearly suffocated by the smoke coming from the other stacks at the same plant.

F. W. Fischer.

Knoxville, Tenn.

Combination Turbine Generator and Pump Unit

There has been installed recently by the West Boylston Manufacturing Company in its cotton mill at Easthampton, Mass., a combination pumping and electric-generating set which embodies some unusual features. The unit consists of a 75-horsepower steam turbine directly connected to a 30-kilowatt direct-current generator and an 8-inch double-suction pump. The generator is situated next to the turbine with the pump connected beyond.



Elevation of Turbine, Generator and Pump Unit

Flexible couplings are employed between the two machines so that it is possible to cut out the pump and run the generator alone. The tandem arrangement is employed as there is no occasion to run the pump without the generator.

The pump circulates the hot water of the mill-heating system; the generator furnishes excitation for the main generators which provide the power for the mill motors during the day. At night the generator is switched onto the lighting circuit of the mill and thus the turbine carries a 24-hour load at practically all seasons of the year.

During the winter it is necessary to run both the generator and pump at all times; but in the summer months the pump is disconnected and the generator is operated alone. This set runs at 2500 revolutions per minute and the turbine is operated noncondensing, the exhaust being used in the summer for heating the boiler feed water and in the winter for heating the water of the hot-water heating system.

W. H. Williams.

Easthampton, Mass.

Sampling and Analyzing Coal

As the purchase of coal on a B.t.u. basis seems to be coming more general every day, perhaps a description of the system employed in a plant burning from 900 to 1000 tons of coal a day may be of interest.

The coal is received at the dock in barges and is hoisted to the top of the coal tower where it is run through a crusher and is broken up into lumps of uniform size. From the crusher it passes to two weighing hoppers where the sample for analysis is taken. Each weighing hopper has an automatic sampling device that takes about a 6- or 7-pound sample from each hopperful and deposits it in a can reserved for that purpose.

When the boat is light and the last ton has been weighed out, the samples from both hoppers are spread on the floor and thoroughly mixed in one pile, this being quartered down until about 20 pounds of the original sample remains, which is the official sample of coal, no other being recognized.

The sample is then broken up into lumps of about ¼ inch in size and quartered once more. Part of the sample is put in an air-tight glass jar and is used in making the moisture determination; the remainder is run through a mill and ground up as fine as possible, put in a canvas bag, labeled with the necessary information pertaining to the boat from which it was taken, etc., and sent to the laboratory for analysis together with the moisture sample.

Upon reaching the laboratory the fine sample is again quartered and then passed twice through a 60-mesh sieve. A portion of it is placed in a small glass tube for analysis and the remainder is kept for a reserve sample or for a check analysis in case one is needed. The system of analysis employed is the one recommended by the American Society of Chemical Engineers, a brief description of which follows:

About 100 grams of the coarse moisture sample is weighed out into a glass crystallizing dish and then subjected to a temperature of about 110 degrees Fahrenheit for three hours in the drying oven. It is then reweighed and the percentage of moisture calculated from the loss in weight. This moisture determination is very necessary as oftentimes the bill of lading and the coal-tower weights do not agree. The allowable moisture is 4 per cent.; anything over this amount is deducted from the contract weight.

To get comparative results a fine moisture determination is also run; approximately one gram of the fine sample is weighed out and then placed in the drying oven for one hour, when it is reweighed and the moisture in the sample thus determined.

Another gram of the sample is weighed out and placed in a platinum crucible for the proximate analysis—the determination of the fixed carbon, volatile matter and ash. The volatile gases are first driven off by placing the covered crucible over a bunsen burner for seven minutes, when the sample is reweighed. The sample is then placed uncovered over a burner and burned down to ash. Then 100 per cent. minus the sum of the percentages of volatile matter, ash and moisture gives the percentage of fixed carbon.

The B.t.u. determination is made in an Atwater bomb type of calorimeter and the percentage of sulphur is found by titrating and filtering the washings of the calorimeter.

The chemical analysis is practically positive, but there is always a question as to the method of sampling and any new ideas from the readers of POWER will be welcomed.

HOWARD BARR.

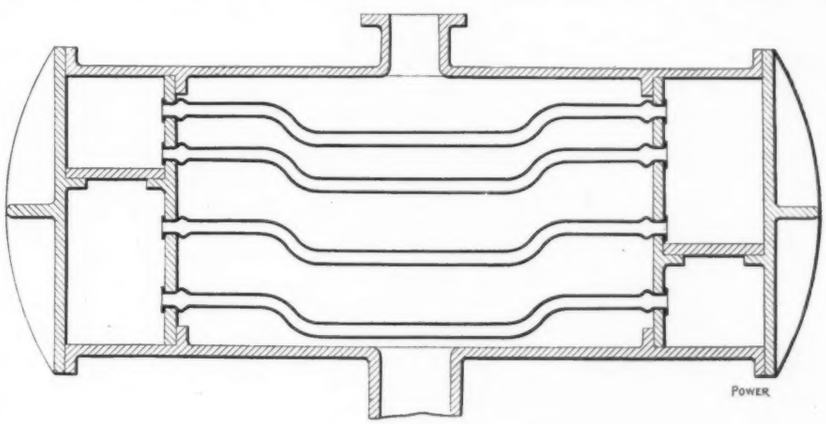
New Rochelle, N. Y.

Retubed the Condenser

In a chemical works a condenser was used to cool a certain vapor from 600 degrees Fahrenheit to a liquid state at approximately 20 degrees Fahrenheit. The vapor came intermittently, so that the condenser had time to cool down to the temperature of the refrigerating bath passing through the tubes. After being subjected to five or six successive heatings and coolings every day for a week, the condenser leaked at every tube end and a mixture of condensed vapor and refrigerating liquid was the result. Re-expanding the joints was not productive of lasting benefit.

It was out of the question to get a suitable condensing apparatus inside of three months, because of the isolated location of the plant, and as there was plenty of tubing on hand the condenser was fixed as shown in the sketch. By leaving a few tubes out here and there and plugging the holes, double-bent tubes were used, the bends being introduced to take care of the expansion. The tubes were expanded tightly and when, four months later, apparatus designed for the work was received, the condenser was still tight.

Similar cases do not present themselves very often, but when a surface condenser leaks at the tubes it is generally very difficult to maintain a proper vacuum. If the condensing water is used in the boilers it may carry along some cylinder oil to the boilers with the usual results.



HOW THE TUBES WERE BENT

Therefore some scheme similar to the above should be adopted to keep the tubes tight. The condenser may be somewhat larger, but it will prevent some unanticipated troubles.

P. P. FENAUN.

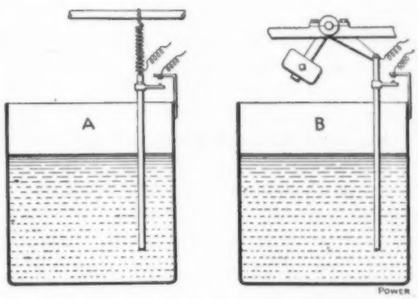
Lynn, Mass.

Water Tank Signal System

I had the problem of a tank signal to solve some months ago and the results may be of interest.

The chief feature lies in the use of a heavier than water body to operate the contacts instead of the usual float.

A galvanized-iron rod, or a galvanized-iron pipe of a length about equal to the depth of the water, is suspended in the tank, either from a helical spring, as shown at *A*, or from a counterbalanced lever, as shown at *B*.



WATER-TANK SIGNAL SYSTEMS

The upper end of the spring, or the lever, is placed at such a hight that when the tank is empty the suspended rod or pipe will just clear the tank bottom.

On filling the tank the rod will rise, allowing the spring to close or lowering the counterbalance weight an amount depending on the weight of the rod and the stiffness of the spring or the arrangement of the counterbalancing apparatus. This rising of the operating rod is because the rod is lighter when immersed in water. A little experimenting will enable one to arrive at the strength of spring or form of lever required.

The spring application of the foregoing principle is virtually frictionless; the lever device introduces only the friction of a single roller bearing. Either of these devices will therefore operate signals capable of the most minute ad-

justment, a feature hardly obtainable in any of the usual devices, which ordinarily move by more or less irregular jerks.

The electrical end of this interesting problem has been already well discussed in other articles, and needs no further comment. The mechanical advantages of this apparatus, as well as its cheapness, are obvious.

GEORGE A. MAIN.

Daytona, Fla.

Cost of Steam to the Contractor

I was recently asked to estimate the cost of steam supplied to a contractor for operating a hoisting outfit, which consisted of a 7x10-inch duplex hoisting engine and a steam turbine for swinging the boom.

Steam from the boilers at a pressure of 125 pounds gage was supplied through 200 feet of 2-inch pipe to the engine and turbine, which exhausted to the atmosphere. The capacity of each bucket was one cubic yard and its weight 700 pounds; the hook and pulley weighed 200 pounds. As 1 cubic yard of gravel weighed 2800 pounds the total weight lifted each time was 3700 pounds. The average hight the buckets were lifted each time was 40 feet. A record of several days showed that the average number of buckets lifted daily was 100, or 10 buckets hourly. The work done per hour was therefore 1,480,000 foot-pounds, or practically ¾ horsepower.

Allowing 33⅓ per cent. for friction of the pulleys, cable and engine, the power developed by the engine for hoisting the loaded buckets averaged one indicated horsepower per hour, and another indicated horsepower for operating the boom. As the amount of steam for this engine and turbine is about 50 pounds per indicated horsepower per hour, the consumption of steam for power purposes was 100 pounds per hour.

The heat loss per square foot per hour per degree of difference between the inside and outside temperatures of the pipe is 3 B.t.u. As the temperature of steam at 125 pounds gage pressure is 353 degrees Fahrenheit and the estimated outside temperature drop during the work would be 63 degrees Fahrenheit, there would be a difference of 290 degrees Fahrenheit.

The radiating surface of 200 feet of 2-inch pipe, including a few feet of 1-inch pipe, is approximately 130 square feet, and the heat loss per hour was estimated as 113,100 B.t.u.

The latent heat in one pound of steam at 125 pounds is 868 B.t.u.; therefore, the condensation of steam was 130 pounds per hour. As Kent's rate of condensation in an 8-inch bare steam pipe for 130 square feet of radiating surface with an average temperature difference of 272 degrees Fahrenheit is 110 pounds of steam per hour, it would appear that, with proper allowance for a greater temperature difference and smaller pipe, 130 pounds per hour is conservative. An allowance of 20 pounds must be made for leakage in the pipe line. This condensation and leakage loss was therefore 150 pounds per hour, or 1650 pounds for the 11 hours per day. The steam for power purposes being 1000 pounds per day, the total steam used by the contractor was approximately 2650 pounds per day.

The total boiler-house expense averaged $1650 per month and the amount of steam furnished the mill is 3,575,000 pounds per month; therefore, I figured that a rate of 0.46 per 1000 pounds would be about right. For 2650 pounds of steam per day the cost would be $1.22.

Twenty per cent. is a conservative figure to add to this cost to allow for interest, depreciation and covenience of the steam plant, making the total cost of steam per day supplied to the contractor $1.46 or, in round numbers, $1.50.

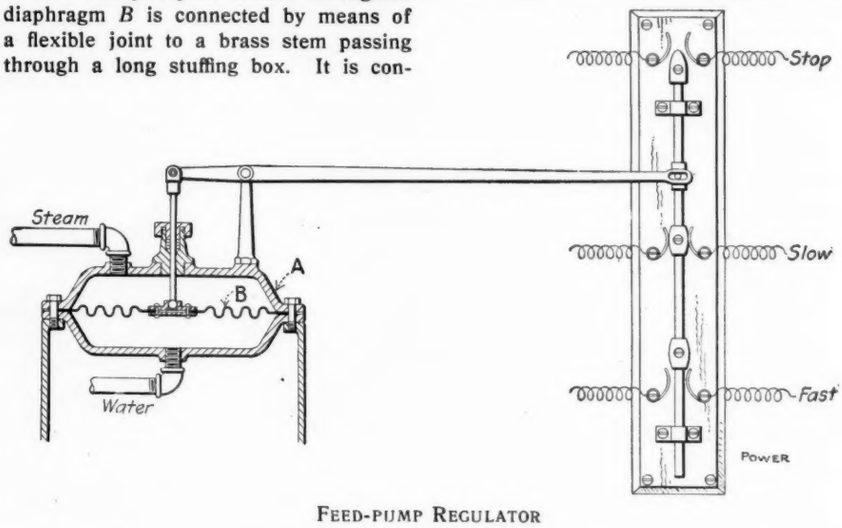
L. L. LOOMER.

Waterbury, Conn.

Boiler Feed Pump Regulator

The accompanying illustration shows a device for regulating the water level in a boiler, the power-feed pump of which is automatically controlled by a series of electromagnets which increase or decrease the speed of the motor driving the pump.

A sectional view of the casing is shown at *A*. The phosphor-bronze corrugated diaphragm *B* is connected by means of a flexible joint to a brass stem passing through a long stuffing box. It is connected at the upper end to the rod controlling the magnets.



FEED-PUMP REGULATOR

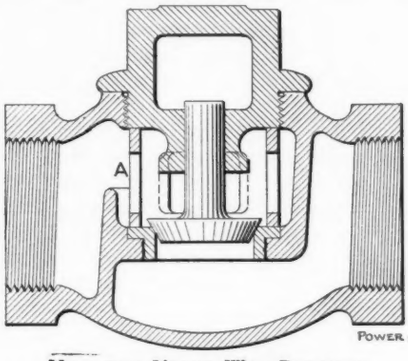
The distance from the fulcrum to the center of the stem is small compared to the length of the arm; thus a very slight displacement of the diaphragm will give several inches of upward or downward movement at the panel. The brass blocks are movable and can be easily adjusted to the proper position. A closer adjustment can be made through the lengthening or shortening of the stem by means of a long thread and a lock nut. Steam and water connections are made in the same way for a regulator of the piston type.

C. A. MAYER.

Hoboken, N. J.

Emergency Check Valve Repair

Some time ago a 2½-inch check valve failed on a feed line leading to a boiler. The boiler was temporarily cut out and the bonnet of the check valve removed,



HOW THE VALVE WAS REPAIRED

when it was found that the valve seat had worked out of place, the threads having all been worn smooth.

How to repair this valve while in place was a puzzle, but finally the scheme of holding the seat in place by the bonnet was suggested. After taking several measurements, a short section of 3¼-inch boiler tube answered the purpose. The section of tube was made with three openings in its sides, as shown at *A*. When placed in position in the check valve, it came between the bonnet and the seat, holding the latter in position with the disk working inside the tube section, the water passing through the three openings on its way to the boiler.

CHARLES E. NIGH.

Morgantown, W. Va.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues

Babcock & Wilcox Headers, Tubes and Baffle Walls

In the issue of July 18 appears an article on page 105 entitled "Babcock & Wilcox Headers, Tubes and Baffle Walls," by R. E. Pairman, who asks for the opinion of POWER readers. It so happens that I have had charge of Babcock & Wilcox marine boilers, 18 tubes wide and 12 high, fitted with single headers; that is, each one holds the ends of 12 tubes 4 inches in diameter. These headers are made of a very high grade of steel. Two or three small cracks have shown on different occasions near the edge of a handhole, but were very small, and had been caused by severe "setting up" on the plates and afterward the use of a hammer and piece of steel bar to calk around the edges of the plates that did not seat well. This operation had been a regular thing after cleaning the tubes, and was practised even while pressure was on the boiler, varying from 200 to 240 pounds, by a former chief engineer.

Of course, I stopped this practice and such few slight leaks as developed were temporarily stopped by peening lightly over the crack. Later these were welded with the electric process and they gave no further sign of trouble.

Tubes which bow have been remedied by regulating the draft to prevent cold air from entering the furnace. Lack of water or of proper circulation and the consequent overheating sometimes cause bowing of tubes. Flaring the nipples is a good plan but not necessary with tubes. With horizontal baffles I have experienced no trouble whatever.

J. A. MCVAY.

San Francisco, Cal.

Cost of Furnace Upkeep

The article by Mr. Howard in the August 15 issue, concerning the "Cost of Furnace Upkeep," is quite complete.

We make it a business never to renew a side wall or furnace lining until at least 4 inches or one course of firebrick has been either burned or broken out. If small holes are burned or broken out of the linings, pulverize old pieces of firebrick, and mix them with a shale mortar into what bricklayers call ganister, a very thick mortar, and with this thoroughly pack up all holes. It is surprising how this will glaze over and add to the durability of the wall. Shale mortar, if a little salt is added, is equally as good as a great deal of the fireclay on the market and less expensive. The shale, of course, should be thoroughly pulverized before being wet and then mixed to the consistency of a thin batter or grout when used in laying up firebrick.

Blowoff pipes must be protected from the fire, especially where cast-iron elbows are used. This can be very effectively and economically done by building a single-course firebrick wall on three sides of the pipe, leaving the side next to the rear end open for the inspection of the pipe. A pier should be built from the bottom of the combustion chamber up to the elbow and then the wall should be carried up tight against the bottom of the boiler.

Where cast-iron or other rear-end doors prove troublesome from warping and letting in air, we find that to remove these doors entirely, leaving the iron frame in the wall and filling the space with a single-course wall of ordinary brick laid in shale mortar, is a stunt worth trying. This wall can be kept plastered in case cracks appear. It will last a surprisingly long while and is very easily removed in case any work is found necessary on the rear end of the boiler, and if the least bit of care is used the brick can be used over and over again. For convenience in cleaning the combustion chamber and inspecting, we have an 18x 24-inch cast-iron door on either side of the blowoff pipe. With this arrangement it is easy to ascertain whether there is any work required on the rear end without bothering the wall of brick above.

In conclusion, I wish to say that the do-it-now idea should not be overlooked in keeping up furnaces.

THOMAS M. STERLING.

Middlebranch, O.

Mr. Howard's letter in the August 15 issue on the above subject is interesting.

A few weeks ago we had a discussion on this same subject in Illinois Association No. 28, National Association of Stationary Engineers. The consensus of opinion was that it cost from 40 to 75 cents per boiler-horsepower per year to maintain the furnaces and the brickwork of the settings. These figures were the averages covering several years.

It cost me for a 1950-horsepower plant —Stirling boilers, extended-front Murphy furnaces—$900, $1350, $1120 and $1460 for four consecutive years. This makes a total of $4830, or 62 cents per horsepower per year, average. The plant contained three 500- and two 225-horsepower boilers. The cost of maintaining the brickwork proper amounted to 80 per cent. of the total expense. The figures quoted cover only the work done by regular masons and do not include such work as was done by firemen and water tenders in making repairs of small breaks.

Some of the members claimed to be able to maintain boiler settings for 33⅓ cents per horsepower per year and one man said that it cost him almost $1. Of course, these figures are affected by the nature of the plant, the kind of work it is doing, the nature of the fuel, etc.

C. W. NAYLOR.

Chicago, Ill.

Need of Well Informed Engineers

Considerable space has been devoted of late in the columns of POWER to articles dealing with isolated-plant management and the inroads that have been and are being made on it by the central station.

Various suggestions have been made for the keeping of suitable records and data, which can be readily referred to if needed; the cost of production per kilowatt has been dealt with at some length, as has the importance of selecting the right kind of supplies.

The machinery in a plant may be the finest, but there are very few plant owners who stop long enough to consider that their fine machinery ought to have the best men to care for it. In nine cases out of ten, low-priced labor is hired and in the course of time things begin to happen and everything in the plant stands badly in need of repair. The consequence is that rather than spend the amount of money required to place the plant in working order central-station service is installed, and, although the owner is not aware of it, he is annually paying out about three times as much as it would cost him to put his plant in shape and run it, because he is compelled to pay more for his current than if he made it himself.

The reason that so few engineers are able to compute the cost of production is not so much their lack of knowledge as their lack of information along such lines, as the cost of the original outfit, the cost of insurance, taxes, depreciation, interest on the investment and a few other things which are included in the costs of running a plant.

Why do not the owners of plants realize that the engineer ought to have this information and present it to him? Then the engineer could prepare himself for his fight with the central-station intruder and wallop him so hard when he puts in an appearance that he will gladly walk on the other side of the street whenever he has occasion to pass that way.

H. H. BURLEY.

Brooklyn, N. Y.

Emergency and the Man

The article on "Emergency and the Man" in a recent issue interested me very much.

Mr. Leslie says he was "both severely criticized and highly praised," but he does not say what the critic would have done under like circumstances. My strong impression is that he could not tell just what he would have done at the moment.

To say that one should do this or do that when an emergency arises is no argument, and yet how common it is to hear and, for that matter, for oneself to say, "I would do" this or that, when viewing a case in cold blood. As a matter of fact, you or I would as likely do just the opposite when confronting an emergency.

Did you ever have a boiler tube blow out with 125 pounds steam behind it, and a heavy fire in the furnace, when you chanced to be in the immediate vicinity? If you have not, you may.

I am not saying but what you would do the proper thing, but it will all depend on the condition of your nervous system at that moment.

The presiding officer, as Mr. Leslie states, who changed the topic from "what to do" to "what did you do?" in an emergency showed wonderful good sense.

Some years ago the writer made a business visit to a planing and molding mill not a thousand miles from the Bronx, and was surprised to find the workmen in a state of confusion. Some were running one way and some another; others were shutting down their machines and joining the excited men about the place. All I could learn was that there was trouble in the boiler room, as they put it.

Curiosity prompted me to ask for the foreman and I was told that he was down in the boiler room. Hastening in that direction I found a man coming up the stairs much excited and I asked him what the trouble was. He informed me that the engineer had gone down town and the fireman had reported that he would have to shut down as the engine was lifting off its foundation. I followed him into the basement, where I found a high-speed engine of perhaps 100 horsepower literally suspended from a heavy driving belt which ran vertically up to the line shaft in the mill above.

I suggested that they tighten down all the anchor nuts to start with. It was stated that this had been done several times, but the trouble soon returned.

It was manifest that the whole equipment was unstable and could not carry its load except with a heavy tension on that vertical driving belt.

The foreman was worried because he could not maintain the necessary speed on the machines and had to shut down until the engineer returned. I told him if he would furnish some timbers and some help I would keep him running all right. He did this and then went up to start what mills he could.

In an hour or so I had securely shored down and braced the whole business fore and aft and the mill was again in full swing.

After sitting around for quite a while to see that the timbers did not work loose and fall over on the belt, or start some steam pipe leaking, and also to give the engineer an opportunity to return and thank me—which did not happen—I left, taking with me the satisfaction of having rendered a good service.

O. C. WILSON.

New York City.

Lubricator Condensing Chamber

In the August 15 issue, J. W. Dickson, in reply to Mr. Wallace, says regarding the lubricator condensing chamber that it will condense a greater volume of steam in a given time in its present position than it will if placed 2 feet above the lubricator. I do not see how the position will make any difference.

I agree with Mr. Dickson that there is no advantage in the operation of the lubricator by placing the condensing chamber in any other position and that there is no need of draining the water from the condensing chamber in refilling; on the contrary, it should not be drained.

If the lubricator is filled before it is entirely empty it will start at once if the condensing chamber is not drained, and the condensing chamber will keep cool and will not tarnish the polish.

I do not think the lubricator would look as well with the condenser placed 2 feet above the lubricator, as Mr. Wallace suggests, and there will be little or no difference in the operation either way so far as the position of the condensing chamber is concerned. The chamber was originally intended to be ornamental.

Many lubricators have no condensing chamber, and are very good ones at that; therefore, I do not believe the condensing chamber is necessary. If it is used it should be left where the makers put it, on the lubricator. No trouble will be had in starting after refilling if the water valve is closed before the drain is opened, and opened last before regulating the feed.

J. C. HAWKINS.

Hyattsville, Md.

Teaching the Boy a Trade

Your editorial in the July 11 issue on the above subject certainly contains much food for thought, and impels me to make a few suggestions.

There is no doubt but that if more attention were paid to the boys' natural inclination by the parents and greater opportunities were provided by employers and educators to properly shape and direct their latent abilities, more bright boys would endeavor to become skilled mechanics than is now the case.

The old apprentice system of our forefathers has practically ceased to exist, a condition to be sincerely regretted as, so far, nothing has been brought forward to take its place. This loss had not been felt until recent years, because the important positions have continued to be held by the skilled men produced under this system. Too much credit cannot be given to those old-time master mechanics who felt their responsibility to their apprentices and made every effort to impart their knowledge to them. There are many successful men of this generation —now rapidly passing away—who laid the foundations of their success under such conditions.

At the present time there are very few apprentices because, except in a few instances, no effort is being made to teach the boys a trade. Generally all that these apprentices learn is what they can absorb by personal contact with the work, as the foremen and managers are too busy and too much interested in increasing the output and decreasing the cost to consider the future welfare of the apprentice and of the industry. That apprentices do sometimes acquire sound information is due more to accident than to design; as to teaching them the knowledge necessary to a thorough craftsman, that seems to be out of the question. These conditions have been in force so long and the apprentice system has fallen into such ill repute that it would take years of patient effort to bring it to the position it had occupied if such a course were considered to be advisable.

The present system of works management is also a large contributing cause for the scarcity of skilled mechanics. The old system taught a trade from the ground up; the new system, by its manifold divisions of labor, frequently teaches each mechanic only a single operation. It does not require the ability to look far

into the future to see that such a narrow system cannot produce broad-gaged foremen and managers. Since it is impossible to find skilled mechanics when needed, it is necessary to formulate some plan that will appeal to boys of ability and will give them the opportunity of thoroughly learning a trade. This may be done by the employers alone or in connection with the public-school system.

It will be found upon further consideration that no mere system for increasing the number of skilled mechanics will suffice to settle this problem unless they are suitably rewarded. Unless the reward is made in proportion to the effort demanded, few young men will undertake the years of preliminary training, and of these few the majority will afterward desert.

To come down to hard facts, the low rate of compensation is the real cause of the scarcity of skilled mechanics. An increase at this point will be a step in the right direction that will do more to attract bright boys to the trades and to keep them there than anything else that can be said or done.

GUY WISE.

Philadelphia, Penn.

Jet Condensers

The writer was interested in the editorial "Condensers," appearing in the August 8 issue of POWER. It calls attention to the statement often made that there is an element of danger in the operation of a jet condenser because it is possible under certain conditions to flood the engine cylinder.

A few years ago I happened to be employed in a street-railway power plant which had cross-compound condensing engines with jet condensers. The engines, being direct connected and having heavy flywheels, would run some five or six minutes after the steam was shut off.

One night when all the cars were in and the steam had been shut off the engine that was running, there was a misunderstanding of signals between the engineer in charge and a new fireman who was on duty. It caused the steam supply to the condenser to be shut off. The engineer, who was at the switchboard, which was on one side of the engine room, the condenser being in the basement on the other side, noticed nothing wrong until a severe pounding started in the low-pressure cylinder.

This condenser was provided with an automatic vacuum-breaker, but enough water got into the engine to completely wreck the low-pressure cylinder.

Automatic vacuum-breakers, as ordinarily furnished with jet condensers, will break the vacuum in time, but not soon enough to save the engine under these conditions.

Therefore I advise engineers to tap the exhaust pipe close to the engine and put in a valve, so that the vacuum can be quickly broken in case of need. A 1½-inch globe valve will do the trick.

A. S. SPECHT.

Belmont, Mass.

Steam Drum to Prevent Wet Steam

Mr. Gilbert, who referred to a cement plant in his letter in the issue of August 15, will be pleased to hear that we have entirely eliminated the priming trouble.

Mr. Gilbert and I spent many months in investigating and experimenting on the boilers and feed water to stop the priming, and as the trouble was considerably lessened when using three boilers instead of two, we came to the conclusion that there was insufficient steam capacity in the drums of two boilers, hence Mr. Gilbert's idea of an auxiliary steam drum.

The greatest cause of the priming and burning of flues was the organic matter in the feed water, which was at its worst when pumping into the reservoir and at the end of the year, when the water in the reservoir was low and we were drawing from the bottom valve. This organic matter and mud were found, on opening a boiler, to be so near the specific gravity of the water that they might almost have been-said to be in solution, and were circulating with the water in the boiler, making the use of the skimmers and the blowing down of the boilers of very little benefit. It also necessitated the forcing of the boilers. After the priming the engine valves would be choked up with sodium chloride and mud, the former being so much in excess as to lead us to believe that it was this salt which caused the priming. But even now that we have eliminated the priming and are running the boilers at 25 per cent. overload continuously, an analysis of a concentrated sample still shows NaCl to run as high as formerly.

To get rid of the organic matter, temporary coke filters were installed until we have completed our settling tanks, and the water will then be treated with lime and iron sulphate similar to the system employed in the St. Louis water works.

Another means of preventing our trouble is by the use of an electrical arrangement by means of which we synchronize the valves of our engines so that one takes steam while the other is exhausting.

These devices, together with the fact that we run our boilers a shorter time when possible and blow them down more frequently, have entirely gotten rid of the priming trouble.

Mr. Gilbert's idea would certainly help in the case of other boilers in use in this part of the country where the analysis of the water shows no organic matter but a considerably high amount of alkaline salts.

W. J. PRICE.

El Paso, Tex.

Paper Gaskets

In reading the practical letters which appear in POWER from time to time, one is frequently reminded of something similar, or relatively similar, in his own career, which otherwise would, perhaps, remain forgotten. Many a valuable idea has become lost because no association of ideas occurs to restore the memory concerning it. But men who read POWER every week are given plenty of ideas to call back things that they had done at some time or other, and they should be glad of the opportunity of giving valuable information to a fellow engineer.

Leroy D. White's letter, in the August 15 issue, on "Tarred Paper Gaskets" made me think of the time that I used up all the old drawings in the company's drawing office, to make gaskets for the tube plates of National water-tube boilers. The asbestos jointing which we had been using was not so satisfactory as might be desired for that particular service, so we conceived the idea of using old and otherwise worthless drawings.

The gaskets were made of the proper size and soaked in boiled linseed oil. They never leaked in eight years, although they were always made of drawing paper and treated with linseed oil.

If the metallic surfaces are in fair shape, drawing paper so used will make an enduring joint. I offer this experience to readers for whatever it may be worth. It is at least worthy of a trial.

CHARLES J. MASON.

Scranton, Penn.

Water Hammer

C. J. Harden, in the issue for August 8, gives a good explanation of the causes of a boiler exploding when cut into a steam line having a lower pressure than that in the boiler. He also shows how such accidents may be prevented.

However, he claims that the explosion is not caused by water hammer and it seems to me his whole argument is against him in this respect. I think the simplest and most practical way to knock a hole in a boiler is to hit it with a hammer, and as a water hammer is usually about the only implement one will find lying around inside a boiler with steam up, it certainly must be the tool that does the business. He is right when he says that the water is lifted with great force.

Now, if this water holds together in an even sheet it will simply compress the steam and there will be no explosion provided the boiler is reasonably sound. But, the water is more likely to burst through the steam cushion, especially in the vicinity of the steam outlet, and there results a powerful water hammer against the boiler plate.

FRED BOONE.

Vernon, Tex.

Trouble with Leaking Tubes

I read with interest Mr. Beaton's article in the September 5 issue. Burnt plates, tube sheets and tube ends, usually caused by neglect to keep sufficient water in the boiler or to remove the scale and mud around the tubes are the cause of many leaks. I once took charge of four boilers which had been used only two years. When I came the tube ends leaked badly. There was much scale to remove from these boilers at each cleaning, but this should not have caused the beads to wear away. The tube ends were found to be very brittle when rolled with the expander. Most of the men were new to the plant, so it was hard to get any of the history of the boilers. However, after a few months I learned that one of my predecessors on taking charge of the plant had found the tubes to be filled with one solid mass of scale. The scale was removed but the tube ends were badly affected. The only way these tubes could be kept tight was to put into the boilers, after each cleaning, 12 pounds of bran or meal.

In some parts of the country the fuel obtainable is very severe on the fire sheets and the tube ends of internally fired boilers. Also, the water may be of the artesian-well kind and, being very hard, has an injurious effect on the tubes, making it necessary to expand and recalk them every year.

I see no reason why through braces should cause tubes to leak, for they could not be badly affected by expansion or contraction unless it were exceptionally severe, as when feeding cold water directly into the braced part of the boiler. If Mr. Reimers should place a scale or straight-edge across the head near the brace when the boiler is cold and again when it is hot, he could determine with the aid of thickness feelers the amount the braces draw in the heads by contraction. Gusset braces have been found to cause leakage and fracture of plates on account of their being too rigid.

One of the most stubborn cases of leakage of boiler seams and tubes was in a large office-building plant. The plant had been in operation 18 years and the boilers were replaced by six new ones 66 inches in diameter and 18 feet long. They were made in two courses, making but one girth seam just back of the bridgewall with the back sheet lapping outside the front sheet.

After being installed for 10 weeks they began to leak around the girth seams and the tube ends. A boilermaker calked the seams and expanded and beaded the tubes. In less than a week the boilers were leaking worse than ever. Grease deposit was suspected and opening the boilers a very small amount was found, although every joint along the steam main and piping throughout the engine room showed signs of grease oozing through the gaskets.

An examination of the return tank was made and a little oil was found along the water line. The grease separators were all examined and the drip traps were cleaned, but the only oil visible was a few very small spots on the water in the return tank. Finally, the oil and the returns were analyzed and it was found that the oil after entering the boilers with the water, and even before entering the boilers became thoroughly mixed with it. This was overcome by putting in a filtering system on the end of the return pipes. Strange as it may seem, the oil appeared to dissolve and settle in the form of mud to the bottom of the boilers.

Here is a mystery. The old boilers were in service 18 years and never showed any signs of grease deposit or leakage at the girth seams. If the grease separators were in bad working condition or the float valves stuck in their seats this would allow the oil to accumulate in the separators and fill them up; it would then be carried through the heating system back to the boilers. I think a discussion of the effects of oil in boilers may be of interest.

R. A. CULTRA.

Cambridge, Mass.

Installing Oil Tanks

W. W. Warner asks if any reader of POWER will give him an idea on how to transfer fuel oil cheaply from tank cars to storage tanks. The tank cars are 3 feet below the bottom of the storage tanks and "it must be borne in mind that oil is somewhat more difficult to handle in freezing weather than in warm."

My experience has been with gold and silver mines in the mountains, where there were hillsides on which I could build "switchbacks" in the railroad track to get the tank cars above the storage tanks. Mr. Warner might accomplish the desired result by a trestle, in which case gravity would help; but even with the cars above the storage tanks, in freezing weather the demurrage on the car would likely be heavy without some assistance by gravity.

Manifestly, Mr. Warner will have to force the oil up hill through a pipe, and in freezing weather it needs some force to make it run down hill even. I have tried putting steam coils into the tank cars and heating the oil in that way for two or three days to let it run out of a 4-inch opening at the bottom; it would then have to be pumped up to the storage tanks while warm if the storage was above the car outlet. While the warmth facilitates the pumping and the passage of the oil through the conduits to the storage tanks, this method takes too many heat units and too much steam energy. I have seen a "car house" built over a tank buried in the ground. The building was kept warm with stoves and by the exhaust steam in heating radiators, and the car was shoved into this house. Possibly Mr. Warner might pump the oil from the warm car house up to his tanks in the same manner as is done with any other method of heating.

Both of these methods of heating oil in tank cars will accomplish results if the expense is no object, but at the mines, where we use compressed air under 80 pounds to 110 pounds gage pressure, I have found it convenient and economical to tap a small air line into the top of the tank car and set the pressure up, on top of the oil, as high as desired. The oil will then flow through the 4-inch opening in the bottom of the tank, and probably would flow up to the storage tanks if the pressure was high enough. This method cannot be used with steam direct from the boilers on account of the condensation. It is satisfactory only with air pressure, and in warm weather will unload a car in a surprisingly short time; even in winter, where the cars are above the storage, the time of unloading a tank is greatly shortened over any other method.

The economy of it lies in the fact that what air is put in the tank is never lost until the tank is empty, and it requires just one tank of air to unload a whole car. A small compressor run off a countershaft or pulley could be installed, using the car for an air receiver, and a few minutes' run every hour would keep the gage pressure at any desired figure. Perhaps even a hand pump compressor could be used, or if hydraulic pressure can be had a water motor might keep the pressure up on the tank. The principle of the blow torch and the oil burner is carried out one step further. Put the pressure behind the oil and it will flow.

LETSON BALLIET.

Tonopah, Nev.

Engine Runs with Steam Valves Closed

The letter in the September 5 issue by O. Lantz in regard to the engine running with both admission valves closed is interesting and I would like to see a couple of diagrams from the engine.

The expansion lines of the diagrams undoubtedly should show very plainly a serious leak in the valve.

I suppose the engine under discussion is noncondensing, and I think it would have been better had Mr. Lantz stated the conditions a little more plainly, giving the details of the piping, etc.

If the steam valves admit steam after they have been closed, the following are the most common causes: Leaky valves or seats, steam passing by the ends of the valves, insufficient lap or probably, if the valves are double ported, there is too much lap, admitting steam over the top edges of the valve.

J. W. DICKSON.

Memphis, Tenn.

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POWER

Give the Gases Room

Several years ago a boiler builder sent a pair of boilers to a Southern manufacturer who used wood fuel. After a time another pair of boilers was ordered. When these boilers were shipped, by some blunder a pair of cast-iron fronts, having the firing doors and grate-supporting brackets a foot further from the shell than standard practice, were sent with them.

It was not discovered until several days after the boilers had gone that the wrong fronts had been sent and the best course of action to be taken in the case was not clear. It was finally decided to wait until the purchaser complained and then send him the right front castings, with profuse apologies for the error.

In due course of time a check covering the final payment was received, accompanying a letter asking for a price on two more boiler fronts similar to the last pair, to be used in replacing the first ones. The letter said that the new arrangement gave the fire more room to burn, made less smoke and required a great deal less wood for the same work.

This is just what should have been expected. Wherever the flame comes in contact with the comparatively cool surfaces of the boiler it is immediately extinguished, and that portion of unburned gas goes up the chimney without giving up all of its heat.

With anthracite and other short-flame fuels containing only a small percentage of volatile matter, the gases are all burned without coming in contact with the shell and the ordinary boiler setting gives a fair degree of efficiency.

But for coals of the long flaming variety, with a large volatile content, the distance from the boiler shell should be such that contact of the burning gas with the shell is at least improbable.

Probably the best furnace for burning ordinary bituminous coal with hand firing is the plain flat grate with a firebrick arch for the purpose of maintaining a high combustion-chamber temperature. In short, the dutch oven in some form will be found the most economical furnace.

That furnace construction to be avoided above all others for the burning of coal having twenty per cent. or more of volatile matter is the one with the boiler directly above the grates and so near to it that the flames touch the iron.

Gains in power-plant efficiency in the future must come largely, if not almost entirely, from the boiler room, and with the improvement that will come when the intelligent fireman feeds a furnace intelligently designed for an intelligent owner, the municipal smoke inspector's occupation will be gone or the office will become a sinecure.

Chimneys

Very tall chimneys have been characterized by one writer as monuments to the folly of their builders, and the advocates of mechanical draft have endeavored to prove that the chimney is practically useless. However, in the face of this and despite all arguments to the contrary, the number of chimneys is increasing and the number of them which are higher than one hundred and fifty feet, and whose increased hight and cost are not justified by their efficiency according to some writers, is rapidly increasing.

In the modern power plant the function of the chimney is twofold: It supplies draft and carries the waste gases to such a hight that they will be dissipated in the atmosphere without damaging the adjacent property. This latter function is, in many cases, the most important reason for the existence of the chimney and the draft it produces is a useful byproduct. The biggest and highest chimney in existence—fifty feet in diameter at the top and five hundred and six feet high—was constructed to carry off the waste gases of the Washoe smelter. This extreme hight, which later may be increased to five hundred and fifty-six feet, was adopted in order to discharge the gases at such a hight that damage to surrounding property would be eliminated; furthermore, the base of this chimney is on a high hill several hundred feet above the smelter.

In and near cities is the natural location of the large steam power plant. In such localities real estate has a large potential value for residential and business purposes and it is absolutely necessary to conduct the gases of combustion to a sufficient hight to insure their thorough dissipation without damaging the surrounding property.

The difficulties which may result from real or fancied claims for damages are by no means imaginary. In Montana the Anaconda Copper Mining Company has encountered numerous claims from neighboring ranchmen for damages based upon the destruction of vegetation by the

waste gases from their smelters. A commission, composed of three members, one selected by the company, one by the State of Montana and a third selected by these two, has been appointed to investigate the trouble. In Pittsburg the Jones & Laughlin Steel Company has had considerable trouble from claims concerning the escape of ore dust from their blast furnaces, which are located in the Monongahela valley just below Oakland's residential district. This dust is carried into Schenley park and has caused considerable trouble at the Phipps Conservatory. The Carnegie Institute in Pittsburg has found it necessary to adopt a very extensive system of air filtration for the ventilation of its museum and library in order to eliminate dust and soot.

Numerous power and manufacturing plants in various parts of the country have found that claims for soot damages to residence property were readily traced to their chimneys. In many of these cases while the individual claim was small, their aggregate was large and troublesome. One of the results of soot distributed over the neighborhood is a hostile public sentiment which may make its influence felt in many devious ways by the concern which has fallen under the ban.

A tall chimney is not necessarily an architectural monstrosity, but severe simplicity is more effective than thistle-top effects.

Making Good

One of the common complaints of chief engineers against their assistants has been that they will not take responsibility when difficulties arise, but at once call for the chief, regardless of the hour or the circumstances. Generally the trouble amounts to but little. In one instance it was the stopping up of the bottom connection to a water column, a matter that any engineer should have been able to deal with without calling for assistance. In another instance a flywheel worked loose on the shaft and the chief was called to superintend the tightening of the nuts on the bolts in the split hub of the flywheel.

The man who makes good must produce results on his own initiative and he must not confine his efforts to working out problems along old, well beaten paths.

One engineer made good when he installed a line of steam piping in the construction of which he incorporated expansion loops of his own design and placed drop legs in the line to provide for suitable drainage and assist in taking care of the expansion of the pipe, in spite of the assertion by other engineers that the loops would not work, or if they did, the joints would leak because of the expansion and contraction.

In a certain small plant the engineer wanted a damper regulator, but the firm would not purchase it. He thereupon set about making one which, when put to work, kept the steam pressure within a three-pound limit. This engineer is now operating a larger and better equipped plant and receives a higher salary.

Another engineer desired to present facts and figures to his employers and in order to do so intelligently and accurately he worked out a system of report sheets which were most complete and would be a credit to any engineer. Thousands of engineers have read of his method of keeping his plant records. This man would have no trouble in obtaining a better position should he so desire.

The Lighting of Power Stations

Power-station lighting is an old and threadbare topic, and the only excuse for referring to it again is the fact that, like the strain of original sin said to have been planted in the race some centuries ago, its defections continue to make trouble without any limit as to place and person. One cannot explain why it is that some of the lighting companies, most progressive in equipping their customers' establishments with first-class layouts of lamps and shades, are such persistent violators of the rudimentary rules for illumination, not to mention good taste, inside their own stations; but such is the fact. With all that has been written lately concerning illumination there should be no need of again going over the old ground and pointing out the absolutely necessary practice of placing lamps so that their direct and insistent rays cannot glare into the human eye. Screening the lamp or at least putting it outside the range of normal vision is one of the fundamental principles of good illumination, and beyond this the problem is merely one of detailed methods of obtaining the maximum illumination for a given cost, so far as the work may be done in good taste. Yet the continued use of bare lamps in front of switchboard instruments threatens the eyesight of the operating engineer, handicaps him in taking readings rapidly and accurately, and at a critical moment in the synchronizing of generating units or the handling of rheostats in connection with frequency changes may lead to serious consequences.

The whole question of station lighting is assuming more importance as the value of machinery under the supervision of each employee increases. Sooner or later it will be recognized that good lighting is an instrumental factor in the precision and efficiency of the administration of a modern generating station. Money is now spent in large amounts to insure the utmost refinements of switching service, remote control and operating flexibility in general, and that is as it should be; but without an ample supply of properly controlled illumination the service is bound to fall short, more or less, of the modern requirements of continuity and regulation. Particularly in important substations handling high-voltage service is rapid action necessary in times of line difficulty. In dealing with extra high potentials it is necessary to spring to the station switchboard at the first instant trouble appears outside the plant, and the correct handling of the machinery so as to keep the largest possible percentage of the load from falling out demands a standard of instrument illumination that is frequently not in existence. Only less important is the use of reflector lamps in front of pressure gages and water columns in boiler rooms, and in connection with all thermometers and important indicating instruments used in auxiliary operation.

The amount of electrical energy required for switchboard and other station lighting is ordinarily comparatively small, but in the course of a month it runs up into a noticeable total of kilowatt-hours. There ought to be a chance to economize here by the use of tungsten lamps of low candlepower and possibly of low voltage. In the latter case the filaments are thick enough to promise long life, and the activity of such lamps in station service is distinctly of the long-hour class. Very little has as yet been done with the tungsten lamp of small size in power-house service, but there is certainly a chance to secure illumination by its use at low expense, combined with a genuine improvement in the character of the light delivered. With all the recent progress in electric-sign construction for service by low candlepowered tungsten lamps there ought to be something done in bettering switchboard illumination. It is surprising what a couple of four-candlepower lamps taking five watts each will do in front of a good reflector when placed above the scale of an important indicating instrument.

An engineer recently took charge of a plant, the engine room of which was one of those "show places" that so delight the eye. Turbines, engines, everything, were decorated with an abundance of brass pipe, railings, etc., and kept highly polished. Within a week the new chief changed all this, and two coats of black paint took the place of the brass polish. "I will find work in the boiler room for the men who have been rubbing brass," said he. Possibly he went a little too far, but he has cut 20 per cent. off the coal bill. The boiler room is now more comfortable and the work easier, and it will not be so difficult to hold first-class men. There is a hint here worth a little thought.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it

Boiler Specifications

Give specifications for a 150-horsepower boiler, to carry 150 pounds pressure; diameter and length of the boiler, the thickness of the sheet, diameter of the tubes, thickness and tensile strength of the sheet. The efficiency of the joint is to be 87 per cent.

H. D. M.

The dimentions should be: Shell, 6 feet 6 inches diameter by 16 feet head to head; shell plate, $\frac{5}{16}$ inch thick; butt straps, ½ inch thick; diameter of rivet holes, $1\frac{1}{16}$ inches; tensile strength of shell, 56,000 pounds; factor of safety, 5. There should be ninety-two 4-inch tubes, twenty-two 1¼-inch crowfoot braces on each head above the tubes, two 1½-inch through braces and two 1¼-inch crowfoot braces on the rear head below the tubes, and 11x15-inch manholes in the top of the shell and in the front head below the tubes.

Boiler Horsepower

What is a boiler horsepower?

H. E. H.

A boiler horsepower is the ability to evaporate 34½ pounds of water per hour from and at 212 degrees.

Safety Valve Calculations

The area of a safety valve is 3 inches; the lever is 36 inches long by ⅜x1½ inches; it is 3 inches from the valve to the fulcrum; the cast-iron 6-inch ball has a hole through the center ½x2 inches and is placed on the lever 30 inches from the valve; what pressure will it take to make it blow?

A. D. B.

Cast iron weighs 0.26 pound per cubic inch; wrought iron, 0.27 pound. The 6-inch ball contains

$$113.09 - 6 = 107.9 \textit{ cubic inches}$$

and weighs

$$107.09 \times 0.26 = 27.84 \textit{ pounds}$$

The lever weighs

$$0.375 \times 1.5 \times 36 \times 0.27 = 5.46 \textit{ pounds}$$

The weight of the valve and stem are not given and so will be neglected.

The pressures tending to hold the valve to its seat are the weight of the ball multiplied by its distance from the fulcrum plus the weight of the lever multiplied by the distance of its center of gravity from the fulcrum.

$$27.84 \times 27 = 751.68$$
$$5.46 \times 18 = 98.28$$
$$751.68 + 98.28 = 849.96 \textit{ pounds}$$

tending to hold the valve to its seat. The upward pressure per square inch necessary to balance the valve is found by dividing 849.96 by the product of the area of the valve multiplied by the distance from the valve stem to the fulcrum,

$$\frac{849.96}{3 \times 3} = 94.44 \textit{ pounds}$$

Boilers for Given Engine

Give dimensions of a boiler for a 100-horsepower throttling engine; a 100-horsepower automatic engine; a 100-horsepower Corliss engine.

B. G. E.

For a 100-horsepower throttling engine, a boiler 66 inches by 18 feet with sixty 4-inch tubes; for a 100-horsepower automatic engine, a boiler 66 inches by 16 feet with sixty 4-inch tubes; for a 100-horsepower Corliss engine, a boiler 60 inches by 18 inches, with forty-six 4-inch tubes.

Duty of Pumping Engine

A double-acting pump has a plunger 26 inches in diameter and a 44-inch stroke; the plunger has a piston rod 4 inches in diameter extending through both cylinder heads. During a 12-hour duty trial, the total heat supplied to the engine was 188,765,300 B.t.u. The pump made 64,800 strokes. The pressure in the discharge pipe was 160 pounds. The vacuum in the suction pipe was 10 inches, and the difference in level between the gage was 12 feet. What duty was developed?

D. P. E.

Neglecting the slip in the pump cylinder and valves, there were

$$64{,}800 \times 12 \times 62.3 = 48{,}444{,}480 \textit{ pounds of water}$$

pumped against

$$160 \times 2.3 + 12 + 11 = 391 \textit{ feet of head}$$
$$48{,}444{,}480 \times 391 = 18{,}941{,}791{,}680 \textit{ foot-pounds}$$

The duty of a pumping engine is expressed by the equation

$$\frac{\textit{Foot pounds of work done} \times 1{,}000{,}000}{\textit{Total heat units consumed}} = \textit{duty}$$

then

$$\frac{18{,}941{,}791{,}680 \times 1{,}000{,}000}{188{,}765{,}300} = 100{,}345{,}703$$

foot pounds duty

per 1,000,000 heat units supplied.

Wire Drawn Steam

What is meant by wire-drawn steam?

J. O. C.

Steam is wire drawn when it is passed from a higher to a lower pressure through a restricted passage, as a partially opened valve, the valve of a throttling governor or pipes of too small area.

Safe Working Pressure

What is the rule for finding the safe working pressure of a boiler 6x18 feet, ½-inch plate, 50,000 pounds tensile strength, 70 per cent. efficiency of seam and a factor of safety of 5?

F. G. J.

The safe working pressure of a boiler is found by multiplying together the thickness of the plate in inches, the tensile strength of the material in pounds per square inch and the efficiency of the seam, and dividing the product by one-half of the diameter of the shell multiplied by the factor of safety. As a formula it is written:

$$\textit{Safe working pressure} = \frac{\textit{thickness} \times \textit{strength} \times \textit{efficiency}}{\textit{radius} \times \textit{factor of safety}}$$

Substituting the numerical values and solving

$$\frac{0.5 \times 50{,}000 \times 0.70}{36 \times 5} = 97.2 \textit{ pounds}$$

Effect of Inside Lap

What effect will an increase of the inside lap have on a plain slide-valve engine?

H. T. C.

Compression is increased by adding inside lap to a plain slide-valve engine because the addition of lap brings about an earlier exhaust closure and a later release.

Pump Air Chamber

What change in the pipe connection can be made between the feed-water pump and the boilers to prevent the vibration and pound in the pipe?

S. L. W.

Put a sufficient air chamber on the pump or on the end of the boiler-feed main and keep air in it.

Heating and Ventilation

Considered as power plant problems. Layout and operation of systems and apparatus

Troubles of a Hot Water System and Inspection*

By Ira N. Evans†

In the design and installation of hot-water heating systems certain precautions are necessary to prevent deterioration of the piping and insure immunity from leaks. The practice followed in the installation of piping for low-pressure steam systems should be so modified as to prevent annoyance and subsequent expense, which can easily be avoided if proper care is exercised. The main points to be avoided are leaks, air pockets and bypasses or short-circuits.

Leaks can be eliminated by proper testing, inspection and selection of the material entering construction. The fittings should be of the heavy water pattern, such as are required for sprinkler work, of good iron and tapped solid with no bushings as they invariably are the source of leaks. The pipe for hot-water work should be strictly wrought iron and owners and contractors should be sure they get it. It is policy to buy from the manufacturer who rolls nothing but wrought-iron pipe, inasmuch as when mills roll both they are apt to ship either as it is very difficult to determine between wrought iron and very mild steel. Each mill, besides the tags, has its peculiar roll marks and if the pipe selected comes from a mill manufacturing wrought-iron pipe only, the easily inspected roll marks will be a sure indication. Steel pipe is much more liable to pitting than wrought iron, and the slight difference in cost more than pays in better threads.

Where the heating surface is in the form of coils it is sometimes advantageous to order the pipe without threads, with the couplings separate. The mill allows something for pipe with blank ends and where a sufficient quantity is used to warrant a power pipe-threading machine on the job, the cost will be in favor of blank-end pipe.

Adjustable dies only should be used on work of this character as it is impossible to cut proper threads with solid dies with the wide variation in the sizes of pipe to be tapped. When the pipe is so seamed along the weld as to damage the threads, it should be discarded. All nipples should be made of extra-heavy pipe, and when the cutter leaves a bur on the inside, the pipe should be reamed out to reduce the friction. When the pipe is furnished with mill threads and couplings, the latter should be reversed to the opposite end of each piece when used for coils or in full lengths and each coupling leaded and made up tight. All stretched couplings should be discarded and all joints should have two or three threads appearing when made up as they are apt to leak if the threads go to a shoulder.

When inspecting a job of this kind it is a good plan to try a few joints at random with a pair of tongs or a wrench to find out if they can be turned. Workmen are often careless, and these trials will show the amount of sinew used in making the joints. Loose joints are often found to be the cause of leaks when the job is tested. The steamfitter will depend on a loose joint taking up after the plant is in operation from his experience with steam, but it is never the case as the joint will leak worse after the water commences to circulate.

A good lubricant should be used, as white and red lead mixed with boiled oil or some standard pipe grease. Nothing in the nature of a substance to fill the spaces of a loose joint should be used as the joint will leak eventually.

Cast-iron radiators should be tapped solid without bushings, although some radiator companies claim that they cannot furnish screw-nipple radiators without bushings on account of assembling the sections. Good push-nipple radiators are preperable to screw-nipple radiators with bushings. If bushings are used they should be flush, with machine-cut threads put in with a bushing driver.

All water radiators have a top and bottom connection to each section, and the supply connection is always made at the top of the radiator. In this type of radiator steam circulates 50 per cent. better than in the regular steam radiator with a single bottom connection, and the difference in price is very little. Owners and architects would do well to insist on the use of double-connection radiators, whether steam or water were used, as the system would be interchangeable at slight expense and the circulation would be better.

If push-nipple radiators are to be used, the form of nipple and joint should be carefully examined. The nipple should be smooth, with a proper taper, and the casting and nipple should be milled to correspond. The metal used in the nipple should be as nearly immune from corrosion as possible. The thickness and character of the metal comprising the nipple whether push or screw will determine this to a large extent. It may be advisable to break one of the sections to find out the grain of the iron and the position of the core; this will be unnecessary if the water test is made, as defects of this character will show.

All radiators should be tested to 100 pounds water pressure before being distributed in the building independent of any manufacturer's test or guarantee. This can be done with a hand test pump at very little expense. All radiators showing evidence of leaks should be rejected and if many sections break, showing indications of the use of a poor grade of iron or displaced cores, the whole shipment should be rejected; inasmuch as these defects may not cause some of the individual radiators to fail under test, nevertheless it would be taking a risk to install even one radiator of a lot developing the above faults. If the above precautions are observed, trouble from leaky radiators or broken sections will be unknown, and experience usually proves that there is no trouble, but the cost of testing is an exceedingly small percentage of that engendered by replacing ten or twenty thousand feet of defective radiation when the system is in operation and the building is occupied.

When the piping mains and runouts are completed, and before the radiators are connected, the system should be given an expansion test with 50 pounds steam pressure. The gage should be placed at the return end farthest from the steam-supply connection. The job should be thoroughly inspected for faults, and all places where expansion has not been sufficiently provided for should be so rearranged that the piping will be free to move.

After the expansion test, 100 pounds water pressure should be used as a pressure test and all leaky joints taken apart and fixed. In case the hight of the building requires a greater pressure than 100 pounds, the radiators will have to be designed specially for the lower floors.

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This pressure is close to the limit of what the commercial cast-iron radiator will stand without special construction. The working pressure is reduced as the top of the system is reached.

After the radiators are connected a final test should be made with the same pressure, viz., 100 pounds, care being taken to remove all air from the system as completely as possible. The water should remain on the system under pressure three or four days to determine the rate of leakage by the drop in pressure. The apparatus may be taken in sections or one building at a time if there are several. Sal ammoniac placed in the system or calking threaded joints and various other devices are only makeshift remedies for a leaky system of piping as the leaks will reappear again in time.

Where coil surface is used it may be tested with the piping or when possible the coils may be built at the bench and tested in the same manner as the radiators. If steam pressure is available, an efficient method of testing is to connect each coil and let the warm condensation from the steam accumulate, filling the coil with water under pressure.

All valves should have large stuffing boxes with a follower in the gland to hold the packing. The metal in the body should be of sufficient weight so that the steamfitter will not strain the body in connecting the valves. All radiator and riser connections should be made with right and left threads; no unions should be used either on the radiators or the piping. Screwed joints with couplings are preferable on the main pipes with a sufficient number of bolted flange unions for disconnecting without an excessive labor expenditure; flanged fittings are unnecessary except for plant connection.

Heaters will give very little trouble from leaks if proper instructions are given the builders as to the steam and the water pressure under which the system will operate. A test at 200 to 250 pounds will be ample for the steam and water spaces in the live-steam heater, depending on the boiler pressure. The exhaust heater should be tested to 150 pounds in all water spaces and 50 pounds in the steam spaces. At the same time it should be air tight if used in connection with a condensing engine. Boilermakers as a rule are faithful in making these tests as they can be held responsible for leaks and it is expensive to repair them after installation.

If desired, the heaters can be tested with water pressure when the final test is made on the system by disconnecting the drip from each heater and noting if water appears when the pressure is applied. A leaky heater should be repaired at once as the boiler or system is liable to be flooded, depending on the difference in pressure between the water and steam spaces.

Feed-water heater manufacturers generally prefer to put the water through the tubes with the steam outside. In building iron-tube heaters it is customary to reverse this order on account of construction. The exhaust heater has a large diameter; therefore it becomes expensive to make it tight so that the lighter pressure is within the tubes, and the heavier water pressure is held between the tube sheets with the expanded tubes. In the live-steam heater the same practice is followed, but as the diameter is much less the practice can be reversed if desired. Two-inch charcoal-iron boiler tubes are found to be the most economical size for surface in these heaters unless they are exceptionally long.

The large area around the tubes allows a high velocity through the heater with a minimum drop in friction head. This is a contrast to passing the water through very small tubes at a high velocity with a corresponding drop in friction head of 10 or 20 feet.

If the foregoing methods of testing and inspection are followed faithfully the repair bill on the piping system of a water job will be less than for any other system.

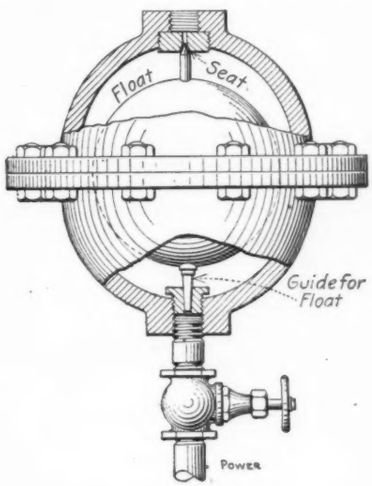


FIG. 1. AIR TRAP

All mains should grade up in the direction of the flow of water, as the air will not work back against the current. Provision should be made to relieve the air at all high points by automatic air traps, but using as few as possible. Any good drain trap turned upside down and so constructed that the valve is above the water level when closed will answer the purpose. If the trap valve is not out of the water when closed, a slug will be blown out each time it discharges; It should be so connected that a vacuum cannot be produced in the trap when it is closed and hold the water level higher than that in the system, thus preventing its operation. The discharge should in any case be connected to some point so that if it does leak it will do no damage.

A sketch of a common form of air trap is shown in Fig. 1. These must be carefully tested before being put in place as they are very liable to leak and not seat properly.

Dirt will tend to accumulate in the outlet when the traps do not operate for a considerable time; this dirt works down on the seat of the valve and prevents it from tightly closing. For these reasons the reversed steam-drain trap with its float and lever will give greater satisfaction, there being more pressure to seat the valve.

When risers are connected to the supply main the runouts should be taken from the bottom and be so graded down that an air pocket cannot be formed at the top of the riser and shut it off. This trouble may be further aggravated if the riser expands upward. Radiators can be connected to mains where convenient and thus relieve the system of air, and, although not automatic, the remainder of the job is not interfered with beyond the one radiator. All radiators should be provided with key air valves whether needed or not. Where mains are reduced, eccentric fittings or reducers should be used so that the level of the top of the pipe will be maintained without air pockets.

The piping should be so arranged and sized that no bypasses or short-circuits occur. The velocity necessary on a proper working hot-water system should be something over 5 feet per second in the mains, depending on the size, distance and total head on the pump.

It is good practice to run individual returns from each building of a group separately to the pump, using a common flow pipe. This gives an opportunity of separate regulation for each building, and the cost of the separate returns over one large main will not be sufficient to offset the advantages gained. A valve and thermometer should be provided at the header for each return.

The return from any section should start from the first unit connected to the supply main and increase in size as the supply main diminishes. The above features are very important in designing a system of this type inasmuch as it equalizes the flow where the exact size of pipe cannot be used because of the large differences in capacities between some of the commercial pipe sizes.

Lock stop valves should never be used to equalize the flow for different sections or radiators; in cases where this is made necessary the arrangement of mains is at fault. On a large job it is impossible to set these lock-shield valves to give perfect satisfaction under all conditions and any change in the setting throws the whole system out. Individual regulation of the different sections should be at the main header in the engine room.

If the mains are properly designed according to the friction head, quantity

of water and distance, the lock-shield valves will be unnecessary.

The placing of these valves is the same thing as using resistance in an electrical line to obtain the proper voltage for individual lamps when the wiring design is defective. The most frequent mistake in designing this class of system is the use of too large mains and pumps with too little capacity. At the same time, the high velocities increase the liability of bypassing and require a more careful design in piping arrangement.

When additions are made to a hot-water plant care should be taken that the drop in head for all sections is as nearly equal to that of the pump as is possible. When too large a main is used on an existing plant it acts as does a short-circuit on a dynamo; the head and speed of the pump are constant and the increase in gallons due to enlarging the main overloads the machine. When the large branch is throttled to equalize the flow, that particular building will have a sluggish circulation, due to the low velocity. If the building added is too large for the existing plant the pump should be modified to suit the changed condition.

The same velocities cannot be used for the mains throughout on a hot-water system on account of the wide range in loss in head per unit distance of length for the different pipe sizes. The mains cannot be designed properly according to a constant number of square feet of heating surface for each commercial size, as the drop in temperature on the system, head on the pump and distance vary the discharge of water. A 2-inch pipe may take care of 2000 square feet of surface in one portion of a plant and be too small for 1000 square feet in another section.

These points are mentioned as many plants have been laid out on this basis and may have worked fairly well, but due to poor and unequal circulation the main advantages of the system are lost, viz., small drop in temperature, low temperature of outboard water in extreme weather. The entire system may operate on 10 degrees higher temperature of water just to meet the requirements of a small percentage of the heating system.

The proper discharge in gallons and total head should be carefully determined in advance so that the pump manufacturer may furnish a properly designed pump. It is then good practice to see that he delivers what is called for by measuring the head and gallons after installation. Many cases have occurred where the manufacturers' test curves showed proper design and when the apparatus was installed an overload was found on the named capacity and head. A well proved friction formula should be used to determine the capacity and the head for the different mains in all hot-water systems of this class.

One of the frequent objections advanced against the hot-water system is the deterioration and pitting of the iron in heaters and piping, due to the action of the water. This can be avoided by using the same water over and over with the minimum of waste and leakage possible. If the water from any cause is changed in the system to any considerable extent it will cause rapid deterioration in the piping. Attaching a hose to the system to obtain warm water for washing purposes should be prohibited for the above reason and the fact that the heating capacity of the heaters would be interfered with to the extent of the amount of new cold water introduced to replace that drawn off.

Leaks from automatic feeders and leaky draw-off cocks connected to the sewer are a prolific source of trouble, as the leaks cannot be observed. The automatic water feeder is a device to supply water to the system, and is placed on the expansion tank when it is at the highest point of the system to keep the water level constant and the system full. This combination would keep the system full when at the same time a ½-inch stream of water may be passing through the system for months. In all cases of deterioration of piping or heaters that have come to the writer's attention the trouble could be traced to outside water entering the system for a considerable period. The water, after being used in the system for some months, becomes charged with hydrogen gas which will burn at the air valves when the system is drawn down. This hydrogen gas, in small amounts, comes from the dissociation of the water under the continued action of heat. When new water is introduced into the system, additional air in solution is driven out of the water and peroxide of hydrogen is formed which is a very active oxidizing agent.

Due to the possibility of leaking draw-offs, it is safer practice to place the expansion tank in the engine room at the base of the system under the immediate supervision of the engineer. The latter will then be cognizant of any change in the water level of the system whether the system is losing water or not. In small installations and places where the construction compels the use of the overhead expansion tank with the water feeder, it should be arranged as in Fig. 2 and be frequently inspected after it is in operation.

The city water pressure should be tested carefully to see that it is great enough to flow into the system against the static head as it sometimes fails, leaving the system partially empty. The expansion tank in all cases should be connected to the return or point of lowest pressure when the pump is in operation as any other point is liable to give a false water level.

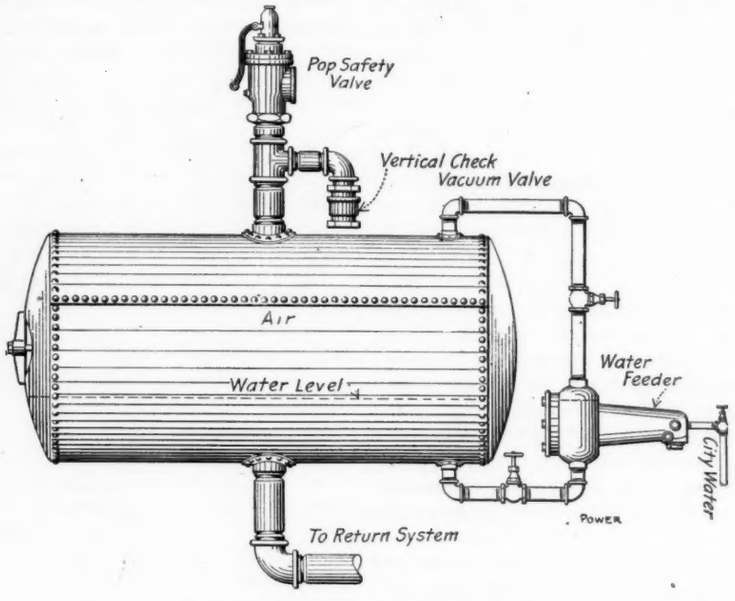


FIG. 2. OVERHEAD EXPANSION TANK

Experience has proved it to be the best practice to keep the system full during the summer as the water, with all air excluded, will act as a protection to the piping against deterioration. The system should be drawn off and flushed out once a year, say two or three weeks before the end of the heating season. The few days' operation after refilling will give an opportunity to exclude all possible air, and the system is then ready for instant operation. It is desirable sometimes, even in summer, to start up the heating system with a low temperature for a few hours, especially during a long period of damp weather. This is easily done with a water system, while

with steam it would be a lot of trouble and would cause almost as much discomfort from excessive heat as from dampness.

Due to the practice of using low water temperatures and large differences between the supply and return on gravity water systems, the idea has become prevalent that hot-water systems require more radiation than for low-pressure steam. This is not so as the circulation of steam, even when vacuum is applied, is apt to be hindered by air at times, or if the pressure is very low and the connections are small, a vacuum may be produced in the radiator, thus cooling a portion of the surface because of the heavy condensation and inadequate steam supply. This occurs often on indirect radiation with cold air supply.

In the case of hot water with forced circulation, due to the high specific heat of the water and a positive and rapid circulation, the transmission of the heating surface is greater than with steam for the same temperatures. If the water is operated at a temperature of 200 degrees average, with a drop on the system of 20 degrees or less, the same amount of radiation will be ample that would be required for a steam system operated at atmospheric pressure, or 212 degrees. The temperature of the circulated water is determined entirely by that of the gases or steam used in the heaters. If high-pressure steam is used with no exhaust the water may be circulated up to 280 degrees and a corresponding reduction made in the amount of heating surface installed over a system designed to operate on 200 degrees and below.

It is safe to calculate the radiation for water systems of this type in the same manner as for steam systems with the same temperature and corresponding pressure, with the added assurance of a positive circulation.

It is advantageous to operate water systems at about 10 pounds greater pressure than the static head of the system. If the water is to be operated above 212 degrees, say 280 degrees, this pressure would have to be increased slightly beyond that corresponding to the steam pressure to keep the water in a liquid state.

All hot-water jobs should be protected from excessive pressure by a nickel-seated, brass, water-relief valve on the return set at the maximum pressure allowable on the system. Under no condition should the outlet of the valve be so connected as to prevent annoyance, as when it operates the system requires immediate attention. Separate pop valves are sometimes placed on the pump casings for additional protection. These pop valves should be tested at intervals and only the very best of valves should be used for this purpose as the seats are liable to stick on the cheaper grades.

In the design of the pump casings sufficient metal should be used to stand the greatest static head on the system. The standard pump may be all right for the circulating head and too light for the static pressure. These data should be given the manufacturer that he may strengthen the casing if necessary. Solid follower pumps are very inefficient and it is preferable to use high-speed hollow bronze follower turbine pumps with motors or steam turbines for prime movers.

The necessary repairs to radiator connections and returns of steam-heating systems are well known, also the noise from water hammer when the steam is turned on. The repairs are made necessary by the sudden heating when steam is turned on a cold pipe, which causes expansion strains. The condition is aggravated by the water from the condensed steam flowing on the bottom of the pipes with the steam on top, causing sudden and unequal strains on the joints. Due to the above occurrences water hammer on a steam job is often associated with the possible damage of flood from the hot-water system. In the latter case, as the system is full of water heated gradually under pressure, there is no possibility of sudden expansion strains, water hammer or noise at any time.

The question of the possibility of freezing is invariably introduced when hot-water systems are under discussion. As the water is under considerable pressure and free from air, it would require a somewhat lower temperature than 32 degrees to freeze it. When circulation is maintained, even if no heat were introduced, the water would not freeze. Water has a density 1700 times that of steam at atmospheric pressure and each pound weight of steam has 1000 B.t.u. in latent heat which is available to prevent freezing. The chance of a water system freezing would compare with a steam system as the temperature of the water above 32 degrees multiplied by 1700 is to 1000. These figures are all in favor of the water system. True but the amount of water in the steam system would be proportionally small and this would freeze in a shorter space of time.

A water system left for a long period of time without heat would freeze and would burst with corresponding damage in the same manner as the plumbing or sprinkler work; therefore drawoffs should be provided in the same manner so that the system can be drained quickly if desired. The return pipes on steam systems have been known to freeze while the apparatus was in full operation.

The hot-water system has more or less circulation after the pump is stopped, due to the inertia of the water and the cooling effect at different points in the system, which cause an added flow to regain its equilibrium; this would tend to prevent freezing for at least 48 hours. In a certain case in an open shop-building plant the pump on a new system broke down before the relay pump had been delivered. The heat was off the system 48 hours, and, although the thermometer outside was at zero and the water was not drawn off, it did not freeze.

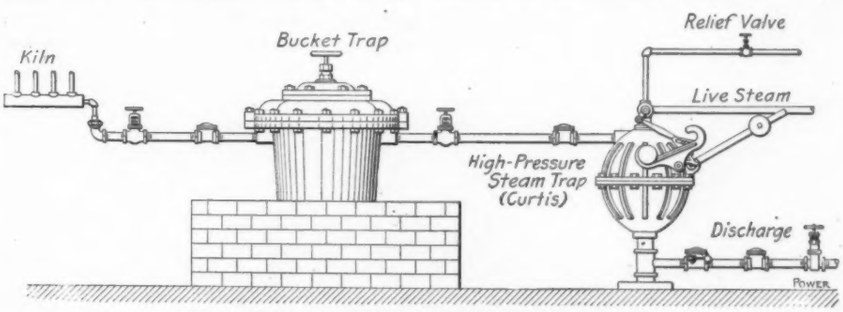
It is not recommended that these chances be taken, but it was expected that the pump would be repaired at any minute during the interval of the shutdown, and if the system had been drawn down it would have been dangerous to fill it with cold water until the weather moderated. A new system should not be tested or filled during extreme winter weather because no circulation can be produced by the pump until the piping in full.

LETTER

Elevating Returns from Coils

It was desired to return the condensation to the boiler room from steam coils located in a dry kiln about 200 feet distant. It was naturally supposed that a pump would be required as it was necessary to elevate the condensation 15 feet before it would flow into the tank in the boiler room.

The tank carried a pressure of about four pounds against which it would be necessary to discharge, and a back pressure of only one pound or so could be carried on the coils in the kiln.



TRAP CONNECTIONS FOR ELEVATING RETURNS

A high-pressure trap failed to work and the arrangement shown in the accompanying illustration was finally devised. The condensation was passed through a bucket trap into an old-style Curtis ball trap and discharged through a back-pressure valve to the tank. The arrangement of the piping is self-explanatory.

W. D. LABADIE.

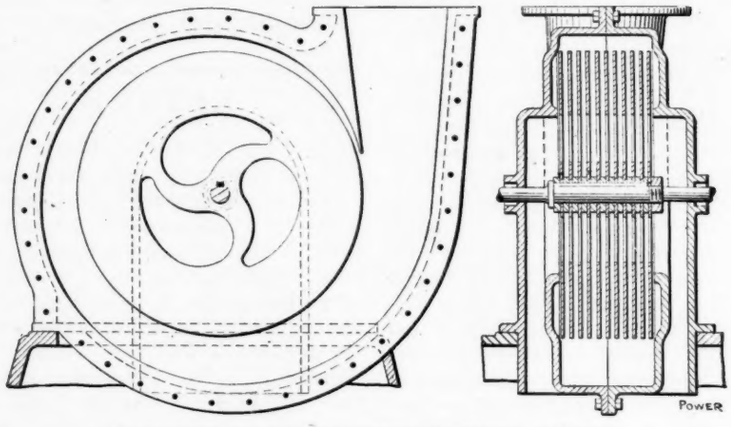
South Bend, Ind.

Prime Mover on Newly Applied Principle

Dr. Nikola Tesla is giving considerable publicity to the exploitation of a newly applied principle in the design of turbines, centrifugal pumps and other apparatus of a similar nature.

It has been demonstrated that to obtain the maximum economy in the employment of a gas or liquid as an agent for converting energy into mechanical power, changes in velocity and direction should be as gradual as possible. To reduce the losses due to impact which occur in the present design of steam turbines, waterwheel, centrifugal pump and the like, Doctor Tesla substitutes plain disks for the bladed disks and vanes now used.

Every fluid, whether a liquid or a gas, has the two physical properties of cohesion and adhesion and it is due to these that the new apparatus can be made to work. The accompanying figure illustrates the design of a centrifugal pump based on the new application. The impeller consists of a number of plain circular disks keyed to the shaft and revolving in a volute casing which is not dissimilar to the casing of an ordinary centrifugal pump. Parts of the disks are cut out so as to form curved spokes at the center. The object of cutting out these portions is to allow the liquid which is being pumped to penetrate readily to the center of the impeller.



LONGITUDINAL AND TRANSVERSE SECTIONS OF PUMP

Due to adhesion, particles of the liquid tend to stick to the surfaces of the disks. But, due to the centrifugal force imparted to the water by the rapid revolution of the disks, there is a tendency of the particles to fly out toward the rim.

The result is that the particles are made to flow with increasing velocity in a spiral of increasing diameter until they are flung off at the rim of the impeller. Because of cohesion, particles not in direct contact with the disks are thrown off in the same way. The number and size of the disks and the speed at which they run as well as the distance between adjacent disks are determined by the nature of the fluid to be pumped and the head against which it is to be forced.

In a steam, water or air turbine the conditions are precisely the same only the operation is reversed, the fluid coming to the machine under pressure and passing through at a high velocity causes the disks to rotate.

According to Doctor Tesla, some of the advantages of this new type of apparatus are, extreme economy, simplicity of construction and operation, low maintenance and, what is most important in marine work, reversibility.

Unloading Coal Cars

BY A. D. WILLIAMS

In thousands of places may be seen a gang of men shoveling coal over the side of a car or a wagon. In a small plant the expense from this item may not be large, but as the fuel bill grows the cost of shoveling becomes a serious item. Usually, the coal must not only be shoveled out of the car but it must be thrown through a door in the side of the building over a sill 8 or 10 feet above the ground. Now, the question is, where does it become economical to do away with the shoveling? A carload of coal usually weighs from 40 to 50 tons (89,600 to 112,000 pounds), and will run a 100-horsepower plant about one month on day turn. The car, however, must be unloaded in 48 hours to avoid the demurrage charges of about $1 per day.

Shovelers are generally paid from $1.50 to $1.75 per day of 10 hours. Under ordinary conditions, one man will handle from 50 to 60 pounds of coal per minute over the side of a car, or from 3000 to 3600 pounds per hour and 30,000 to 36,000 pounds per day. Under a competent foreman, the rate of unloading will increase to 50,000 pounds per day, or 83 pounds per minute, and a picked gang will exceed this rate, though the rate per man will be increased about 20 per cent.

Even this last figure is not the maximum when firing a locomotive, as the coal is pulled down from the tender and thrown on the fire; and one man, opening and closing the fire door himself, will on some runs handle 117 pounds of coal per minute, or 7000 pounds per hour. This work is strenuous while it lasts, but a run fired at this rate rarely lasts over four hours and the fireman has a 24-hour layover at the end of the trip. The locomotive fireman is also paid more than $1.75 per day of 10 hours.

The best shoveling record for handling coal from a high-sided gondola which has come to the writer's knowledge was made by six men, who unloaded 80,640 pounds of coal into a hopper in 44 minutes. This was at the rate of 305 pounds per minute for each man, or 18,300 pounds per hour. This coal had to be placed in a track hopper intended for use with bottom-dump cars, which did not tend to facilitate the speed of handling. This rate probably will not be greatly exceeded, though the men were not played out by any manner of means.

Assuming that 4000 pounds per hour can be unloaded per man, the cost will be 4.375 cents per 1000 pounds of coal. As there are approximately 300 working days in the year the annual wages of one man will be $525, which is the annual interest upon $10,500 at 5 per cent. But as there are other charges besides interest the saving due to the displacement of one man would only justify an investment of about $2000 in coal-handling equipment.

Where one man can unload all of the coal required for a plant he is probably the cheapest and most economical unloader which can be employed. At least one man is required to operate a coal-handling machine even of the simplest kind, though this duty may only require a portion of his time, but a man intelligent enough for this purpose is usually paid from $2.50 to $2.75 per day. Generally two or three men are necessary to operate a coal-handling plant, one to take care of and operate the machinery and one or two laborers to clean up after the machine.

Track hoppers sufficient to permit the unloading of several cars at a time will not cut down the number of men required much below three, as coal will frequently be delivered in hopper-bottom gondolas instead of bottom-dump cars, which require a large part of the load to be shoveled into the hoppers. In winter the coal will freeze in the cars in northern latitudes and may even have to be broken up by explosives or thawed by a steam hose. Where the coal is handled with grab or clamshell buckets one man must operate the hoist and another trim up after and guide the bucket when cleaning up the cars. While these buckets will not work in close corners, they will take out from 80 to 85 per cent. of the coal under favorable conditions.

The several elements which affect the cost of coal-handling equipment are:

Hourly capacity necessary, storage capacity to be covered, and vertical and horizontal distances covered.

Storage capacity will cost from $2 to $15 per ton of 43 cubic feet. The hourly capacity will be fixed by the sizes of the buckets and belts and their speed limitations, while the hight of lift and the distance the coal must travel will fix the length of the conveyer units.

Locomotive cranes with grab buckets are often employed, but their maximum effectiveness can only be realized when they can be spotted at one point and limited to lift and swing.

Gantry bridges with buckets are subject to similar limitations, hoisting and racking being their effective service. When either of these devices is used to transport coal along the runway the useful load is such a small proportion of the dead load and the speeds are so low that the amount of useful work will be extremely slight.

Belt, bucket and scraper conveyers are used for horizontal and vertical transport. Each has its special province and overlaps the others. The type to be used will depend entirely upon the local difficulties to be overcome.

Compounding the Steam Engine

By W. H. Booth

The early compounding of steam engines in Great Britain differed from the practice in America in that the British custom consisted almost entirely in the addition of a high-pressure cylinder to an old engine, no change being made in the low-pressure cylinder and the power of the engine remaining the same.

Some of the earliest compounding was done by a man named McNaught and was always termed "McNaughting." He took in hand the old factory beam engines as he found them at work in the earlier cotton mills. Many of these engines had been originally designed to work with boilers carrying only seven pounds of steam pressure. He found them working with 30 pounds, considerably throttled, for the engines would not stand 30 pounds on their pistons; as it was, many of them lifted their foundation walls. Sometimes the heavy pier of weighty masonry under the cylinder would lift as the steam entered the top of the cylinder; at others, it would be the crank wall that lifted, and more often the cross wall under the columns which supported the entablature beam under the rocking beam center would lift as it was exposed to a double effort of the beam's leverage.

McNaught added a small cylinder which he placed half way between the beam center and the connecting rod. Thus, when the low-pressure cylinder tried to lift the beam wall, the high-pressure cylinder would pull it downward. One cylinder counteracted the other and the beam-center bearings were relieved of stress. So popular was this method of compounding that it was quite a usual practice to make new compound engines on the McNaught plan. Another system of compounding was to place an inclined cylinder the rod of which took hold of the crank pin of the beam engine, and another common arrangement was to employ a quick-running horizontal engine, the exhaust of which passed to an old beam engine. The horizontal engine might or might not be intergeared with the beam engine.

At one place familiar to me an old Boulton & Watt side-lever marine engine, by no means an uncommon type of engine in cotton mills, took its steam from the exhaust of a pair of vertical engines.

In all these various compoundings it was always the addition of high-pressure cylinders, and many old engines were thus worked from boilers carrying 80 pounds pressure. The compounding thus enabled one to obtain the economy of higher pressures and it also saved the outlay for an entirely new engine, giving an extended lease of life to an old and weak engine at a time (1860-64) when cotton manufacturing was passing through a nonprofitable period.

Failure of Mixed Pressure Turbine Installation

By C. A. Tupper

The disastrous consequences of rushing into the use of mixed- or low-pressure steam turbines without first ascertaining with reasonable certainty whether the conditions are suited to such an installation, are illustrated by a case recently reported from one of the mining districts.

The company operates a large property which includes a number of very deep shafts; and for these there have been provided in past years some of the most powerful hoisting engines built. Not long ago it was decided to equip the mine with electric haulage for underground operations, and the first idea appears to have been to purchase the necessary current from a local power company. There were no generating units directly at the mines, and, besides the steam hoists, the company had only compressors in service. No pumps were required, as very little water penetrated the workings, and this was baled out and hoisted in buckets.

While the matter of electric power was under consideration, it was suggested that the exhaust from one of the big hoisting engines be utilized in a mixed-pressure turbine driving an alternating-current generator. Turbine manufacturers were very much interested, and they appear to have made a careful examination of the operating conditions with the result that all but one refused to put in a proposal, stating that the scheme was commercially unfeasible. The mining company also was not sufficiently impressed with its practicability to warrant its purchasing a low- or mixed-pressure turbine; and, for reasons of its own, which were probably connected with plans for future extension, it did not care to install a standard high-pressure unit of any description.

The engineer who conceived the idea of using a mixed-pressure turbine was, however, not to be discouraged; he hit upon the novel expedient of organizing an independent operating company to install the turbine unit, purchasing from the mining company the exhaust steam and whatever live steam might be needed, and selling to the latter company the resulting electric power.

The turbine selected for the service was a mixed-pressure machine to operate condensing at a steam pressure ranging from 16 pounds to 100 pounds absolute and a back pressure on the hoisting engine of 5 pounds. It was coupled direct to a three-phase, 60-cycle, 2300-volt, alternating-current generator, running at 1800 revolutions per minute. The exhaust steam was taken through a regenerator and live steam was automatically shut off or admitted as the exhaust steam became available or not.

The hoist operated in balance with very heavy skips, and when the loaded skip had ascended part way the steam was shut off from the cylinders of the engine. Meanwhile, the exhaust was considerable and it puffed into the regenerator with cyclonic violence. There was enough to run the turbine for a very brief period; then the machine had to depend on live steam until the exhaust from the hoisting engine commenced again. Taken altogether, the power of the unit was developed almost wholly on live steam. Furthermore, the back pressure on the hoisting engine, instead of being only 5 pounds, as predicted, was about double that amount, thus materially lessening the power developed in its cylinders. Under the circumstances, the use of the turbine would appear to have resulted not only in no economy but in an actual loss.

The facts were soon spread abroad and have caused unwarranted injury to the legitimate claims of low-pressure turbines in the extensive district affected, for the reason that the power-using public does not take into account the circumstance that this unit was installed in a place for which it was not adapted. Recently the turbo-generator was put out of commission by an unavoidable accident and it is stated that some changes will be made in the arrangement of the plant before the plan is tried again.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news

"Inertia" Corliss Valve Gear and Improved Dashpot

A new type of admission-valve mechanism, the "inertia gear," is built by the Bates Machine Company, Joliet, Ill., and is now regularly used on all Bates Corliss engines. With this inertia gear the disengaging parts, instead of being forced into and held in their path by springs, rollers or other devices, travel in the desired path by natural forces involved in the movement.

Referring to Fig. 1, the dashpot arm is of bell-crank form, one arm carrying the dashpot rod and the other the catch block. The dashpot arm is keyed to the valve stem and a sleeve on its inner side fits into a bored recess in the steam bonnet, thereby gaining bearing surface.

The steam arm has a liberal bearing surface on the bonnet and is driven by the valve rod in the usual way. A substantial boss on the steam arm carries the latch shaft on the inner end of which is firmly mounted the knock-off bar, these two parts forming practically one solid piece of steel. The knock-off ring is controlled by the governor and carries the knock-off cam and safety cam.

The operating movements are as follows: In opening the valve the valve rod moves to the left, the latch shaft engages with the block and continues in this path until the knock-off bar comes into contact with the knock-off cam and is forced outward, raising the latch until the block is released. The dashpot then comes into action and returns the arm to which the block is attached to the original position. The follower pin is firmly fixed to the steam arm and acts only in the event of the dashpot failing to close the valve.

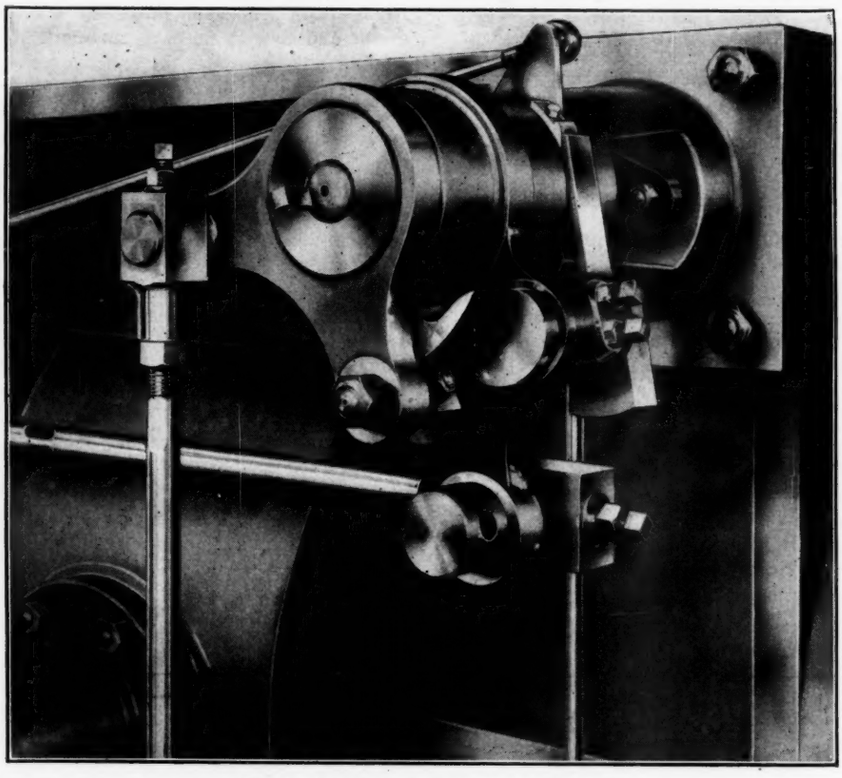


FIG. 1. INERTIA CORLISS VALVE GEAR

The construction and balancing of the latch shaft and its knock-off bar attachment are such that the inertia due to the reciprocating motion and the gravity of the parts assures an automatic latching action at the end of the return stroke between the shaft and block without the use of any spring or other mechanical device, and in turn assists the unlatching at the point of cutoff, thereby reducing the reaction on the governor.

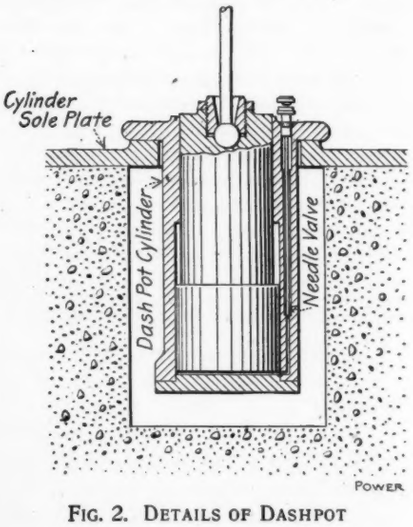


FIG. 2. DETAILS OF DASHPOT

The depth of the latching and the amount of clearance of the catch blocks may be set with the greatest ease while the engine is running at full speed and is accomplished by the two adjusting screws.

This valve gear has been thoroughly tested and found to work positively and quietly up to the limit speed of vacuum dashpots, which is considerably over 250 revolutions per minute.

The dashpot now used on Bates Corliss engines is also of special design and is claimed to be remarkable for quick action, noiseless operation and durability. It is set beneath the soleplate, is made without packing or leather, and the method of cushioning enables it to act over the wide range of lifts without requiring adjustment.

Referring to Fig. 2, the dashpot cylinder and plunger are of two diameters with a ground fit on each. With the plunger at its lowest postion, there remains an annular internal chamber which is full of air. An air passageway is provided from the chamber to a point underneath the plunger, and the area of this passage may be varied by the needle valve to regulate the amount of air transferred to the lower chamber.

In operation, the air is displaced from the annular chamber to the vacuum chamber below the plunger exactly in proportion to the lift of the plunger, the air so transformed forming the cushion. Thus the cushioning effect is always proportionate to its work and the air is driven back and forth without noise within the pot.

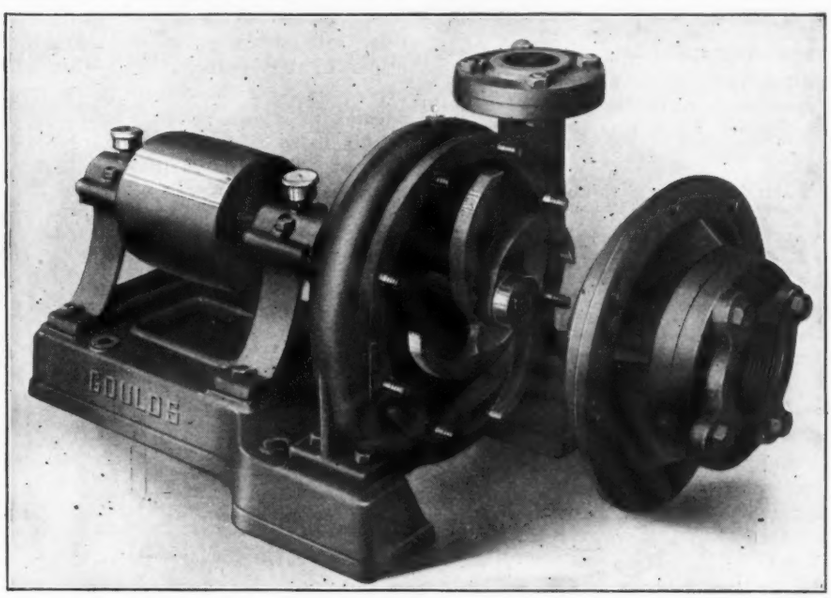
These improvements in valve gear and dashpot afford positive operation of the valves at slow speeds, but their importance is greater as the speed increases.

Goulds Centrifugal Pumps

The Goulds Manufacturing Company, Seneca Falls, N. Y., has just placed on the market an entirely new and improved line of centrifugal pumps. These pumps are furnished in both the single-stage, single-suction and single-stage, double-suction types. Either type may be arranged for belt drive or direct connection to electric motor, gas, gasolene or steam engines, and steam and hydraulic turbines. Both the single-suction and double-suction pumps contain special features. The impeller in the single-suction pump is of the open type and is machined to minimize the clearances between the impeller and the side covers; this feature influences the high efficiency obtained in this pump. The vanes are so designed that maximum economy is had under normal conditions.

Although of the single-suction type, the impeller is so designed that end thrust is eliminated.

The shaft stuffing box has a brass water-sealing ring which prevents air from being drawn into the pump at this point.



ROTOR OF GOULDS CENTRIFUGAL PUMP

The single-stage, double-suction centrifugal pumps are designed with the casing made of two castings bolted together on a horizontal joint. Dividing the casing permits quick and ready access to the interior parts of the pump for inspection without disturbing the pipe connections; this feature is illustrated herewith. The impeller is of the modern inclosed type and develops a high efficiency under the conditions for which the pump is designed. The bearings are of the ring-oiling type, independent of the stuffing boxes, and are provided with removable shells lined with anti-friction metal. The stuffing boxes are provided with brass water-sealing rings.

The double-suction pumps are made for heads up to 150 feet and the single-suction pumps operate against maximum heads of 100 feet.

"Sea" Rings Automatic Piston Packing

"Sea" Rings packing, recently purchased by the H. W. Johns-Manville Company, 100 William street, New York City, is so constructed that it hugs the piston rod, during such times as high-steam pressure is in contact with the stuffing box.

FIG. 1. CONSTRUCTION OF THE RING

These rings are molded of laminated asbestos, flax or duck in wedge form, with their thin end turned inward. There is a hollow space in every ring, between the lip and the heel, as shown in Fig. 1, into which the steam follows, so that the steam itself and not the gland pressure forces the rings against the rod.

Several rings are used in a stuffing box, as shown in Fig. 2, but no one cup leather takes the whole strain, as it is divided among the three, four or more rings, each taking its share in the work of preventing leakage to the atmosphere.

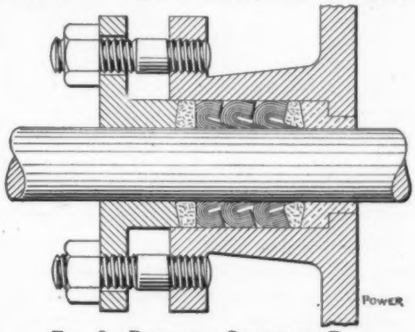


FIG. 2. RINGS IN STUFFING BOX

It is claimed that these rings will withstand 600 degrees Fahrenheit superheat. They work just as well on horizontal as on vertical rods; and are for use on pumps, steam hammers, air compressors or for any other purpose.

New Diagrammeter

The accompanying illustrations show a new device designed to measure steam-engine diagrams. It is used with a scale which is based upon a spring set at 50 pounds; the lines represent inches and fractions of inches which when multiplied by the weight of the spring will indicate the mean effective pressure in pounds.

A diagram with the instrument in a position ready to commence tracing is shown in Figs. 1 and 2. In Fig. 3 is shown the scale employed.

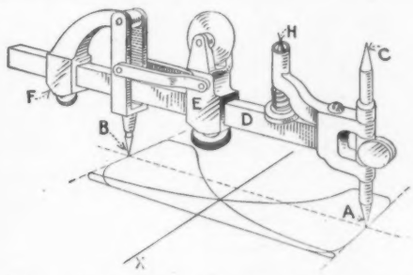


FIG. 1. PLACING THE INSTRUMENT ON THE DIAGRAMS

When measuring a diagram the instrument is placed as in Fig. 1. The fixed point *A* over the diagram is placed over one perpendicular and the adjustable point *B* is placed over the other perpendicular of the area to be measured, and is then secured in such adjusted position. The fixed point *A* has a supplementary point *C*. When in either of the positions shown in Figs. 1 or 2, one or

the other of these points forms a pivot upon which the balance of the instrument may be swung, such points being provided with a movable thumb-piece pivoted to the bracket holding the points.

Mounted on the bar *D* is an adjustable bracket *E*, carrying a sharp-edged roller the periphery of which is in the same plane as the point *C*. This adjustable

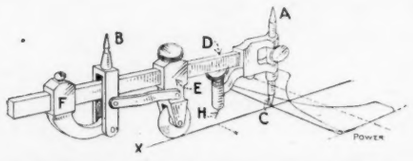


FIG. 2. READY TO TRACE THE DIAGRAM

bracket is connected to the adjustable point *B* by means of links and the adjustment of this point is by means of the member *E*, the latter being provided with a setscrew to hold it in the adjusted position. The bracket *F* may be set at any position on the bar *D* to accommodate the size of the diagrams to be measured.

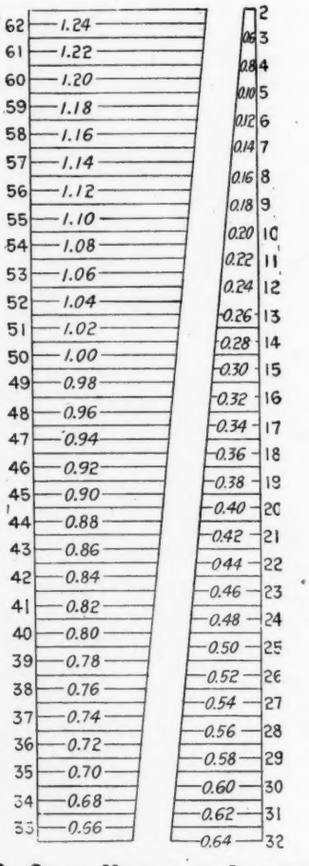


FIG. 3. SCALE USED WITH INSTRUMENT

The instrument is used as follows: It is first employed in the position shown in Fig. 1 in measuring the distance between the perpendiculars of the diagram. The instrument is then reversed and placed in the position shown in Fig. 2, with the point *C* at the junction of the base of the diagrams and a line *X* drawn through the center of these diagrams, the wheel being placed directly on the line. The point *C* is then traced around the boundary lines of one of the diagrams in the direction of the toe. When the tracing of the boundary line has been finished the instrument will rest at an angle to the base line of the diagrams and the center line *X*, and when in this position the marking point or pin *H* is depressed, making a perforation in the paper. The distance from this mark to the center line of the diagram is the mean hight of this diagram, and if such distance be measured off on the scale shown in Fig. 3 the mean effective pressure of steam in pounds may be determined. The opposite diagram on the card will be measured in precisely the same manner, and by this means the mean effective pressure of steam for each stroke of the piston may be readily determined.

This device is the invention of Rudolph Schierbeck, 2620 Master street, Philadelphia, Penn.

Sharood's Automatic Injector Valve

This device is designed to act as a check valve in automatically preventing the escape of vapor or steam and to allow the passage of liquid as it accumulates.

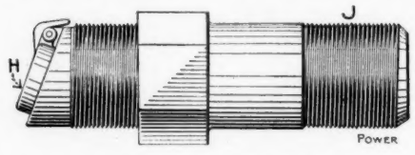


FIG. 1. EXTERIOR OF VALVE BODY

Water in passing through the valve casing maintains a high velocity, creating a vacuum in the pipe to which the valve is attached, and thus rapidly relieving the pipe of condensed water.

In Fig. 1 is shown a longitudinal sectional view of the valve, both ends being threaded for connecting to a pipe line. In Fig. 2 is shown a sectional view of the valve as connected to a pipe. In this view *A* is a common pipe tee with a plug *B* on top and *C* is a union connection. The cones or jets *E*, *F* and *G* are also shown as located in the valve. The strainer *D* keeps the valve free from dirt or sediment. The inlet of the valve is at the right and the water and steam find an outlet through the valve *H* at the end of the valve body.

In the valve are arranged a series of cones so placed that a space is left between the outer face of one and the inner face of the ajacent cone. This arrangement forms a space around the small end of the two cones. The large ends of these cones fit the inside of the pipe and are secured by means of threaded ends and are made tight by means of packing rings. The general arrangement is evident in the sectional view.

Under normal conditions steam will fill the pipe and will be projected through the several cones against the check valve *H*. Steam, it is said, does not open the check valve, but when the steam condenses water fills the pipe and will pass out through the cones. The force of the water will open the check valve and the water will escape through it.

When the valve is to be used with high-pressure steam a disk containing three small openings is inserted in the orifice *L*, thus reducing the orifice and preventing the high-pressure steam from opening the check valve.

This valve is the invention of S. V. Sharood, 263 North Main street, Brockton, Mass.

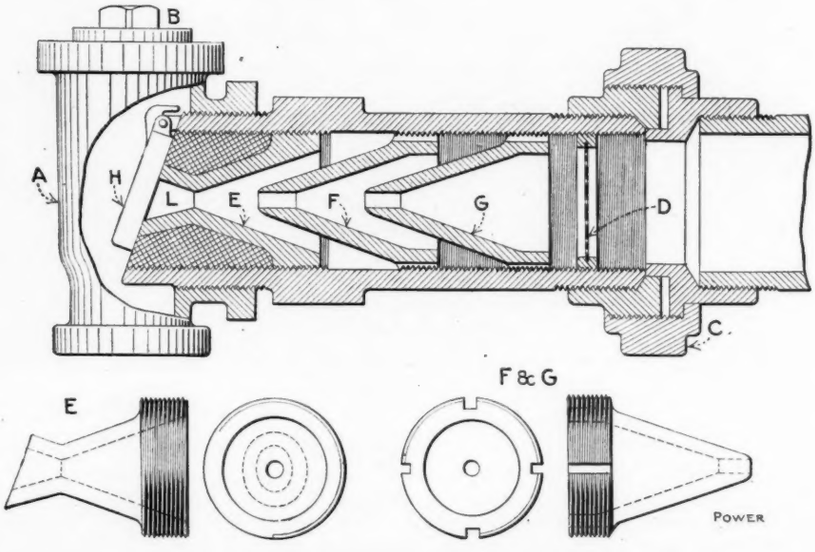


FIG. 2. DETAILS OF VALVE

National Convention N. A. S. E.

The twenty-ninth annual convention of the National Association of Stationary Engineers was called to order at the Music hall in Cincinnati at ten o'clock on Tuesday morning, September 12, by John A. Kerley, chairman of the local committee. After an invocation the convention was welcomed to Ohio by Attorney-General Timothy S. Hogan on behalf of Governor Harmon, who was in the East. Mr. Hogan pictured the developments of the past century and pointed out the important part which the engineer had played in them. A century ago Washington was further from Boston than it is from Japan today. How grateful one should be for the conscientiousness and devotion of the man at the throttle, the man who is behind the industries of America, the greatest industries of the world.

Mayor Louis Schwab welcomed the convention to the city in an address which showed an understanding of the aims, objects and methods of the association quite unusual in the public official. He gave much of the credit for the progress of recent years in steam engineering and in the conservation of the fuel supply to the organization then in convention.

President Carl S. Pearse responded fitly to the addresses of welcome. He reviewed briefly the development of the section in which the convention was held, the beneficial things which the general government is doing for the people and expressed the belief that it is only because we are new at lobbying and apt to neglect the duties which we owe to our profession that some of these governmental activities are not exercised in our behalf.

Walter Draper, president of the Chamber of Commerce, followed with a review of the accomplishments and the hopes of Cincinnati. He paid a tribute to the bravery of the engineer of the Chamber of Commerce, who stuck to his post in the basement of the burning building and kept the elevators running until everybody was safely out.

Vice-president Edward H. Kearney, responding to Mr. Draper's remarks, pointed out the opportunities of the real engineer and showed how he had developed from a small to an important factor in the industrial scale and from a workman had become a man of affairs.

Charles S. Wirmel, State labor commissioner, was the next speaker. It is rumored, by the way, that he is slated for the chief examinership of engineers. He has often attended these conventions as a delegate. He spoke interestingly and understandingly of the work of the association and gave statistics regarding the industries of Ohio and the condition of labor therein. There are 16,000 licensed engineers in the State.

Past President William J. Reynolds responded to the commissioner in a brief, witty sally which brought the introductory exercises to an end.

The president's address, presented in the afternoon, dealt with the apathy of the State deputies and local secretaries and expressed approval of recommendations by deputies for the removal of secretaries who do not attend to their duties. He approved the work done by the State associations and recommended submission of the dates proposed for State conventions to the national president for approval in order to facilitate the attendance of national officers and representatives of the official organ. He recommended the employment of an educator "to act as a bureau of information and to assist local associations in educational work"; also, the adoption of a uniform log or daily report for plants. He urged the importance of continued effort for license legislation, but pointed out that each bill must be submitted to the license committee of the national association for approval before the association can lend it financial or moral support. He reviewed at length the proceedings leading to the suit filed against the association by the former publishers of the *National Engineer* and approved the social activities which have done so much to advertise the association and hold the members together.

The report of the secretary showed the receipts of the year to amount to nearly $31,000, about half of which was profits upon the *National Engineer*. During the past year there have been organized 11 new associations, while 13 of the old have surrendered their charters, 2 of these on account of consolidating with other locals. There have been 1626 members initiated, 1290 dropped out and 31 were expelled. Per capita tax has been paid on 18,402 members, but the total membership, including 821 honorary and associate members, is 20,167. New York State leads the list with 2574, with Ohio a close second at 2461.

The report of the treasurer shows that the total disbursements for the past year have been $22,515, of which $12,632 was for mileage to the Rochester convention. A resolution providing for an organizer at $2000 a year and expenses was voted down.

On Thursday morning the real work of the convention commenced with the report of the credential committee seating 378 delegates.

The educational committee had offered prizes of $100, $50, $25, and three of $10 each to the associations sending in the best set of answers to a series of questions submitted, and recommended that the first and second prizes be divided between Denver No. 1 and Lowell No. 17, which tied with 716.5 points out of a possible 720. Hamilton No. 4, of Ohio, won the third with 689.3; Omaha No. 1, the fourth with 678.9; Butte City No. 1, the fifth with 666.5; and Newark, N. Y., the sixth with 661.4. A gold-plated Lippincott indicator, donated by A. C. Lippincott for award to the author of the best essay on "The Utility of the Steam Engine Indicator as an Essential in a Steam Plant," was given to E. J. Rose, of Detroit No. 1. A Horn planimeter, presented by E. B. Skinner, of the Skinner Engine Company, to be given to the author of the best essay on "The Isolated Steam Plant vs. The Central Power Plant," was awarded to A. W. Miller, of the same association. There were, however, but two contestants for the last prize and these were both Detroit men.

The committee says, with regard to the general contests, "From the small percentage of replies it would appear that the vast majority of the associations either have not the time or inclination to give to progressive work serious attention."

The license committee acknowledged its inability to secure during the past year sufficient data to compile a satisfactory publication of license and boiler-inspection laws now in force, and recommended that some method be sought whereby the committee may render assistance to State committees without waiting for the approval of their bills by the national committee and president, as this is usually prohibitive on account of time.

Proposals to appropriate $5000 for educational and license work, and to reduce the per capita tax from 75 to 60 cents, were defeated.

The national secretary read the roll of members who had died during the year, and a quartet with organ accompaniment rendered several appropriate selections.

The mileage for the present convention was found to amount to $11,976.

It was decided to hold the next convention in Kansas City.

The officers elected for the ensuing year are: President, Edward Kearney, of Boston; vice-president, John F. McGrath, of Chicago; secretary, Fred W. Raven, of Chicago; treasurer, S. B. Forse, of Pittsburg; conductor, Fred L. Ray, of Louisville; doorkeeper, Anthony Deutsch, of Cincinnati; trustee, George Brownhill, of New York. The president appointed Joseph Carney, of New York, as trustee in place of J. H. Van Arsdale, of St. Louis, resigned.

The social program commenced with an informal reception at the Sinton on Monday evening, at which an opportunity was afforded for the older delegates to enjoy a reunion and for the newcomers to get acquainted. On Tuesday evening, The Goldenburg School, presented an original musical play, "A Royal Masquerader," the book of which was written by Grace Delaney Goldenburg, daughter of past national treasurer Dan Delaney, and the music by her husband, William

Smith Goldenburg. The large stage of Music hall was effectively filled by a company and chorus aggregating some 150 persons and the light and catchy music and witty lyrics made a decided hit.

On Wednesday the visitors were the guests of the Lunkenheimer Company, which had chartered the steamer "Island Queen," in which the party to the number of nearly 3000 were conveyed down the river to the Fernbank dam, and then back past Cincinnati to Coney island, where a barbecue with burgoo and ice cream accompaniments was served. Dancing, bowling, the annual baseball game between the engineers and supplymen, races, games, a band concert, etc., made a pleasant afternoon and the party was returned to the city on schedule time. The hosts had anticipated every possible wish and need of their guests, even to providing hospital attendants and facilities in case of accident, but the day passed off without a single mishap and their unobtrusive concern for everybody's comfort and amusement brought to the managers of the Lunkenheimer Company the satisfaction of a thoroughly happy and contented party and many warm expressions of appreciation.

On Thursday evening there was another entertainment at the Music hall at which local and visiting talent united in a successful vaudeville program. A grand ball at the Sinton concluded the week's amusement.

The exhibition held in connection with the convention under the auspices of the National Exhibitors' Association was the largest and best in the career of the association. The Music hall, in one wing of which the exhibition was installed, stands upon historic ground from an exhibition standpoint. Here in a building erected for a sängerbund was held, about the middle of the last century, the first industrial exhibition in this country. These exhibitions were continued until interrupted by the Civil War and resumed in 1871. In 1875 an interesting series of engine tests was conducted at one of these exhibitions by John W. Hill, C. E., and others. Mr. Hill and several of the participants in these older expositions were present. The large hall was divided into a series of booths uniform in arrangement and decoration, lighted with large electric globes and with an effective color scheme. The delegates spent much of their time among the exhibits, and there was a large attendance of local engineers.

In the Life and Accident Association, Past National President James G. Beckerley was reëlected chairman of the board of trustees; J. D. Taylor, secretary-treasurer, and John M. Lynch, trustee. The salary of the secretary-treasurer was fixed at $1200 for the coming year.

The officers elected by the National Exhibitors' Association for the ensuing year are: President, H. H. Ashton, of Boston; vice-president, M. B. Skinner, of Chicago; secretary, Homer Whelpley, of Cleveland; treasurer, William T. Johnson, of Buffalo; executive committee, Louis B. Mann, of New York; H. A. Pastre, of Pittsburg; J. W. Peterson, of New York; Harry Raymond, of Boston; F. E. Sly, of Milwaukee.

Resolutions of sympathy were passed and sent to the family of Edward McCarthy, whose death occurred on August 18 last. Mr. McCarthy was a representative of the George W. Lord Company, of Philadelphia, and had attended many of the National Association of Stationary Engineer meetings in the interest of the company.

Carl S. Pearse, the retiring national president, was presented with a handsome diamond ring, William D. Purcell, the retiring president of the Exhibitors' Association, with a gold watch and chain. The Exhibitors' Association presented John A. Kerley, chairman of the local committee, with a handsome stickpin.

The winners of the four prizes offered by the Ashcroft Manufacturing Company, of Cincinnati, O., were: First prize, Tabor steam- and gas-engine indicator, G. W. Boothe, of Ironton, O.; second prize, Ashcroft averaging planimeter, J. A. Murray, Denver, Colo.; third prize, Coffin averaging planimeter, C. Williams, Providence, R. I.; fourth prize, Ashcroft combination valve grinder, L. A. Henderson, Clinton, Ia.

C. M. Schneider, by a score of 208, won the bowling trophy offered by the Supplymen's Association for the highest score in the bowling contest, and for the first time the Supplymen won the baseball game.

The following firms and companies were represented:

Albany Lubricating Company, Allis-Chalmers Company, American Fabric Belting Company, Huhn Metallic Packing Company, American Radiator Company, American Ship Windlass Company, American Steam Pump Company, American Steam Gauge and Valve Manufacturing Company, Anchor Packing Company, V. D. Anderson & Co., Arctic Ice Machine Company, Armstrong Manufacturing Company, Arrow Boiler Compound Company, Ashton Valve Company, Atlas Rubber and Belting Company, Bird-Archer Company, Bishop-Babcock-Becker Company, Black Diamond Company, S. F. Bowser & Co., Builders' Iron Foundry Company, Burr-Oak Belting Company, A. W. Cadman Manufacturing Company, Cancos Manufacturing Company, The Philip Carey Manufacturing Company, Chapman Valve Company, A. W. Chesterton Company, Clement Restein Company, Cling-Surface Company, Crandall Packing Company, Crane Company, Creachead Manufacturing Company, Crocker-Wheeler Company, Dearborn Drug and Chemical Works, Desmond-Stephan Company, Diamond Power Specialty Company, Eagle Oil and Supply Company, Eagle White Lead Company, Evans, Almirall & Co., Evans Oil Works, Fairbanks Company, Federal Metallic Packing Company, Ferguson Publishing Company, Fisher Governor Company, Franklin Oil Filter Company, France Packing Company, Garlock Packing Company, Greene, Tweed & Co., Gutta-Percha Rubber and Manufacturing Company, Hartford Steam Boiler, Inspection and Insurance Company, Hawkeye Compound Company, Hawks Boiler Company, Hill & Griffith Company, Hills-McCanna Company, Hill Pump Valve Company, Home Rubber Company, Hoover-Owens-Rentschler Company, International Acheson Graphite Company, International Text Book Company, Jenkins Brothers, Joseph Dixon Crucible Company, Kent Lubricating Company, Keystone Lubricating Company, Knopf & Johnson Company, F. & F. Koenigkramer, Lagonda Manufacturing Company, Laidlaw-Dunn-Gordon Company, F. D. Lawrence Electric Company, A. Leschen & Sons Rope Company, Liberty Manufacturing Company, Elliott Company, George W. Lord Company, The Lunkenheimer Company, Lytton Manufacturing Corporation, McCord Manufacturing Company, James McCrea & Co., McDonough Automatic Regulator Company, McLeod & Henry Company, W. B. McVickar Company, Manning, Maxwell & Moore, Marion Machine, Foundry and Supply Company, Mason Regulator Company, Mechanical Rubber Company, Michigan Lubricator Company, *Mining World,* Mineral Products Company, Charles H. Moore Oil Company, Murdock Manufacturing and Supply Company, *National Engineer,* National Tube Company, New Era Manufacturing Company, George M. Newhall Engineering Company, New York Belting and Packing Company, New York and New Jersey Lubricant Company, The F. W. Niebling Company, F. A. Nusbaum Company, Ohio Blower Company, Ohio Grease Lubricant Company, Osborne High Pressure Valve Company, Otis Elevator Company, Peerless Rubber Manufacturing Company, Pennsylvania Oil and Supply Company, The Perolin Company of America, Peterson Engineering Company, Philadelphia Grease Manufacturing Company, Pittsburg Gauge and Supply Company, The William Powell Company, POWER, *Practical Engineer,* Quaker City Rubber Company, Revere Rubber Company, Richardson-Phenix Company, Ridgway Dynamo and Engine Company, Riverside Metal Refining Company, John A. Roebling & Sons, Safety Equipment Manufacturing Company, Scandinavia Belting Company, Schaeffer & Budenberg Manufacturing Company, S. C. Regulator Company, W. H. Simmons & Co., G. L. Simonds & Co., *Southern Engineer,* The C. E. Squires Company, Stand-

ard Oil Company, L. Steigert & Co., Strong, Carlisle & Hammond Company, Terry Steam Turbine Company, Thermoid Rubber Company, Toledo Pipe Threading Machine Company, Trill Indicator Company, Triumph Electric Company, Under-Feed Stoker Company of America, Universal Lubricating Company, United States Graphite Company, The Vanda Company, Henry Vogt Machine Company, R. G. Von Kokeritz & Co., Warren Webster & Co., Westinghouse Air Brake Company, Westinghouse Machine Company, Wickes Boiler Works, Willcox Engineering Company, The D. T. Williams Company, Williams Gauge Company.

Ohio N. A. S. E. State Convention

The Ohio State Association of the National Association of Stationary Engineers held its convention at Cincinnati on the day preceding the national convention. The sessions were held in the Sinton hotel, where John A. Kerley, chairman of the local committee, conducted the introductory exercises.

After an invocation, Scott Small, director of public safety, welcomed the convention to the city in behalf of Mayor Schwab and was responded to by President Eichhorn. National President Pearse then said a few words and the convention went into regular session with 37 delegates qualified.

The secretary reported that there were 41 associations in the State association on June 1, 1910; that one had been admitted since, two had withdrawn, and two dropped from the rolls. There was a net increase in membership of 157. Much of the time was devoted to the discussion of legislative and educational methods and a resolution submitted by the Kentucky State Association favoring the expenditure by the national association of $5000 per year for educational work and in behalf of State license laws was indorsed.

The officers for the ensuing year will be John J. Coughlin, of Hamilton, president; Thomas F. Synnett, of Dayton, vice-president; Joseph J. Ahlers, of Cincinnati, secretary; John E. Radigan, of Cleveland, treasurer; Casper Geise, of Delphos, conductor; T. J. Kolb, of Middletown, doorkeeper; T. E. McFadden, of Cleveland, State deputy.

The retiring president was presented with a past president's jewel, and votes of thanks were tendered to Governor Harmon and Chief Inspector W. E. Haswell for their support of the boiler-inspector law and to the mayor, press, Personal Liberty League and the local committee for attentions bestowed. Lima was selected as the next place of meeting by one vote, Toledo tying on the first ballot.

Evening Technical Courses at Pratt Institute

Practical evening courses for young men employed during the day will be conducted, commencing September 27 and concluding March 22, by the School of Science and Technology, of Pratt Institute. The classes will meet on Monday, Wednesday and Friday of each week at 7:30 p.m.

The courses will include practical mathematics, technical chemistry, industrial and elementary electricity, mechanics, electrical machinery, electrical design, machine design, mechanical drawing, mechanism, steam and steam engines and strength of materials.

Full information regarding these courses may be had by writing to the director of the School of Science and Technology, Pratt Institute, Brooklyn, N. Y.

PERSONAL

Manning E. Rupp, formerly on the Panama canal work, has accepted a position as mechanical engineer with Stanley G. Flagg & Co., of Philadelphia.

Harry H. Atkinson, proprietor of the Economy Lubricating Company, of Boston, Mass., sailed on September 19 from New York for an extended tour of Europe in the interests of the company.

W. E. Haswell, who has been the chief examiner of engineers and chief of boiler inspection in Ohio, has been appointed secretary of the Ohio Board of Administration. This is a consolidation of the administrations of nine important State institutions. It is said that Charles H. Wirmel, at present labor commissioner, and one of the first examiners to be appointed upon the passage of the license law, is slated for the position which Mr. Haswell is leaving.

How the Lubricant Made Good

By H. E. Hopkins

This is a yarn from the "Asbury Park"
In which the proceedings are somewhat dark.
'Twould be hard to prove its veracity,
But this is the way it was spun to me.

This craft plies the waters of New York bay,
And carries for passengers each week day
The men who own railroads and bonds and shares—
Kings of finance and large business affairs.

Billy Richmond, sir, was the chief engineer,
Beloved by his men, to the passengers dear;
And the head chef's name was equally rhythmic,
Billy Richland was his patronymic.

"Billy" did answer for either's first name—
It was from the last ones disaster came
To the engine-room crew 'neath the proud ship's deck,
And trouble there was for a time, by heck!

Chief Richmond had sent to the makers' for grease,
Chef Richland for butter, his stores to increase;
The one wanted grease for to run the "machine,"
And the other some butter for his cuisine.

The grease did not come; the chief made a kick;
To run without grease would raise the Old Nick.

"We sent it, you got it; look 'round in the store,"
Wrote the makers. Up rose the chief with a roar:

"Avast! ye firemen, deckhands and oilers,
Search all the ship, from the decks to the boilers.
If the tub is on the 'Asbury Park,'
I swear I'll have it if we hunt till dark!"

While in the kitchen an oiler judicious
Found in the icebox a tub most suspicious.
Said the garrulous cook: "Wot's all this 'ere fuss?"
"Why," howled the oiler, "this stuff b'longs to us!

"This is not butther, 'tis the grease, if ye plaze;
Oi s'pose ye've used ut in all the ongtrays.
If ut made good cookin', ye've done yerself proud,
Take it from me, Mister Pathrick O'Dowd!"

And thus it turned out that the chief's grease was sent,
But, alas and alack! 'twas wellnigh spent.
'Twas used, it is said, in soup, salad and roast
And also to "butter" the passengers' toast.

It certainly had a proper consistence
To be put within the *pièce de résistance;*
That grease *must* be good which will serve the ménu
And keep the machinery running too!

So here's to both Bills; may their luck increase,
And we hope in future each gets his own "grease."
They've tickled *some* palates with this kind of "ile,"
And here we will leave them with handshake and smile.

Moments with the Ad. Editor

A department for subscribers edited by the advertising service department of Power

That our advertisers are telling the truth in their advertisements is really not such a new thing.

Read this letter which we received last year from Mr. E. J. Kearney, of Kearney & Trecker Company, regarding his advertising in one of our papers:

HILL PUBLISHING COMPANY,
New York.

Gentlemen:

Under separate cover, we are sending you nine half-page and five full-page proofs prepared for the AMERICAN MACHINIST. On three of the full-page advertisements we have substituted in place of "vibration is eliminated" "vibration is reduced to the minimum."

Your Mr. Britton gave the writer a little talk on the advisability of making conservative and true statements in advertising. We would, therefore, wish to avoid making a statement of this kind in connection with our product, although we have great confidence in its rigidity.

Some 15 or 20 years ago there was published in all of the Technical Papers a description of a mammoth steam hammer, made for, and probably by, the Bethlehem Steel Co., of Bethlehem, Pa. This was the largest and last of its kind, and one description of it stated that when it struck a blow on an armour plate, considerable vibration was set up in the Allegheny Mountains. You will, therefore, see how impossible it is to say vibration is absolutely eliminated from any machine tool.

Yours very truly,
KEARNEY & TRECKER CO.
Milwaukee, Wis.

It is significant as the honest attitude of modern advertisers.

Truth in advertising loses nothing, but gains much, by being correctly printed. It's the only way that pays.

Nowadays, manufacturers cannot afford to get business any way except by giving full value for the money.

Advertising serves its main purpose in distributing information, creating confidence and getting people started to buying.

If you are not satisfied with what you buy, you will not be caught again.

The business which is conducted on the basis of a hope for permanency must give value received, or it will die.

That's why only reliable products can be continuously advertised.

Good advertising is the worst enemy of graft, the foe of trickery salesmanship, the conqueror of unfair competition, the promoter of right dealing.

Our readers are more and more realizing this.

We intend to retain this faith by continuing our policy of keeping our advertising columns reliable and clean.

To buy from them is a guarantee of satisfaction.

BUSINESS ITEMS

"The Management and Cleaning of Steam Boilers" is the title of a new booklet just issued by the United States Graphite Company, Saginaw, Mich. The booklet gives some very interesting information about the methods of keeping boilers clean by the use of United States Graphite Company's Mexican boiler graphite. A copy will be gladly sent to any engineer upon application.

The United States Reclamation Service has recently ordered from the Westinghouse Electric and Manufacturing Company for installation on the Boise project, Idaho, three 625-kilovolt-ampere, 22,000-volt, three-phase, air-blast type transformers. The Government has installed on this project a hydroelectric power plant for furnishing energy to motor-driven pumps used for irrigating purposes. As the irrigation season occupies only the summer months, the plant will be kept in part operation during the winter for the purpose of supplying light to the farmer and the small towns on the project.

G. L. Simonds & Co., Chicago, Ill. (sales department, Vulcan Soot Cleaner Company), have just completed the installation of 18 Vulcan soot cleaners on 18 Stirling boilers at the Cleveland Electric Illuminating Company, Cleveland, Ohio. Other recent orders include the Cleveland, Painesville & Eastern Railroad Company, two, for Stirling boilers; the Chicago, Rock Island & Pacific Railroad, five, for Babcock & Wilcox boilers; Albert Trostle & Sons Company, Milwaukee, Wis., two, for Edge Moor boilers; the Marion Light and Heating Company, Marion, Ind., repeat order for seven, for Edge Moor and Stirling boilers; the National Tube Works, at Lorain, Ohio, a repeat order for Babcock & Wilcox boilers; the Edison Illuminating Company, Detroit, Mich., sixth order for Vulcan soot cleaners for Stirling boilers.

The General Fire Extinguisher Company, Providence, R. I., has leased from the Patterson-Allen Engineering Company, 2 Rector street, New York, two Patterson-Allen joint and hydraulic pipe flanging machines to be installed at the Auburn, R. I., plant. Each machine has a capacity for flanging pipe from 1½ to 24 inches in diameter. It has also leased a duplicate of the above machines to the Scully Steel and Iron Company, Chicago, Ill., and is about to close leases with pipe-fitting concerns in Detroit, Pittsburg and Savannah. In order that this method may be well introduced it is flanging pipe, furnishing bends and nozzles from its plant in Jersey City, N. J., and has recently received large orders from Francis Brothers & Jellett, Philadelphia, and the American Shipbuilding Company. Its joint has been specified on several of the largest buildings now being erected in New York City.

The Crosby Steam Gage and Valve Company, for many years prominently identified with the Fort Hill section of Boston, Mass., on September 15 moved its executive offices and show rooms to the recently completed Marshall building, 40 Central street, that city. This building is among the largest and most complete office buildings in Boston and is of modern fireproof construction. The ground floor of the building is occupied by the Boston sales office and show rooms of the Crosby company and is very handsomely equipped. The sixth floor is occupied by the executive offices, which occupy a space of approximately 10,000 square feet. The general office is equipped with the most modern devices of office equipment and includes two large, specially constructed fireproof vaults for the storing of records and papers, and handsome locker and retiring rooms for the office employees. The various private offices of the officers and department heads are elaborately finished throughout in Flemish oak with specially constructed office furniture and fittings. These offices are so arranged as to command a fine view of Boston harbor. The rapidly increasing business and interests of the Crosby Steam Gage and Valve Company have made these changes necessary and it is to be congratulated on its new and handsome home.

NEW EQUIPMENT

Worcester, Mass., contemplates the installation of an incinerating plant.

The Standard Oil Company, Cleveland, Ohio, is erecting a new boiler house.

Steeplechase Park, Coney Island, N. Y., will install a new power plant this winter.

New Britain, Conn., will issue $150,000 bonds for improvements to its water system.

The Bly & Wooster Company, Coahoma, Tex., will install a new power plant at its cotton-ginning plant.

Stanton, Mich., has voted $10,000 bonds for the erection of a municipal waterworks and electric-light plant.

The Occidental Fish Company, Seattle, Wash., will erect a cold-storage and refrigerating plant on Bay street.

The Canadian Niagara Power Company, Niagara Falls, Ont., will spend $125,000 for new turbines and dynamos.

The Alton, Jacksonville & Peoria Electric Railway will erect a new power house at Alton, Ill. Offices are at Alton.

Fallon, Nev., has voted bonds for the installation of a waterworks and sewage system. About $45,000 will be expended.

The San Diego (Cal.) Ice and Cold Storage Company is planning the erection of a new ice and refrigerating plant on K street.

The Oxford Linen Mills, North Brookfield, Mass., has plans for a new power house. Additional dynamo and engine will be installed.

The United Cold Storage Company, Milwaukee, Wis., will erect a $250,000 cold-storage warehouse on Oregon street, near Davidson.

The H. M. Byllesby Company, of Chicago, will expend about $225,000 improving power plants purchased from Sioux Falls (S. D.) Light and Power Company and the Bennett Electric Company.

The city of Brisbane, Queensland, Australia, will receive bids up to January 30, 1912, for the installation of a waterworks system and pumping plant. Address George Johnson, secretary, Metropolitan Water and Sewerage Board, Albert street, Brisbane.

HELP WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

WANTED—An editor and compiler; must be familiar with power plant practice and appliances. Address Box 506, POWER.

WANTED—Thoroughly competent steam specialty salesman; one that can sell high-grade goods. Address "M. M. Co.," POWER.

AN ENGINEER in each town to sell the best rocking grate for steam boilers. Write Martin Grate Co., 281 Dearborn Street, Chicago.

AGENTS WANTED for first-class steam specialty in use throughout United States. Address C. S. Wood, 410 S. 15th St., Philadelphia, Penn.

SALESMEN can make big commissions selling our guaranteed metallic packings as a side line. Address High-Speed Metallic Packing Co., 305 N. Michigan Ave., Chicago.

THE VULCAN SOOT CLEANER offers an exceptional opportunity for power specialty salesmen. For further particulars address G. L. Simonds & Co., 802 Steinway Bldg., Chicago, Ill.

ONE ENGINEER in each town to represent us, your choice of any indicator outfit on the market as a free premium; give your home address and firm employed by. The Olson Mfg. Co., Manitowoc, Wis.

WANTED—High-grade motor and generator repair man, one with transformer experience preferred; alternating- and direct-current apparatus; give reference, experience, stating salary and full particulars. Box 495, POWER.

WANTED—First-class operator with high voltage electrical and steam turbine experience; give reference, stating detailed experience and all important facts and salary expected; none but first class men need apply. Box 496, POWER.

AGENTS WANTED—To sell lubricating oils, belts, hose, paint and varnish, for power machinery, to factories, mills, auto owners, stores, threshers; exclusive territory to right party; oil experience unnecessary. Manufacturers Oil & Grease Co., Cleveland, Ohio.

SELLING AGENTS wanted in important centers for Betson's plastic fire brick; it readily interests everyone having the usual troubles with boiler and furnace fire brick arches and linings. See page 105 of this issue. Betson Plastic Fire Brick Co., Rome, N. Y.

AN ENGINEER; one who has had at least ten years' power station experience and understands boilers, turbines, engines and general uptodate apparatus; an engineer in charge of a medium size generating station; salary $2000 per year or over to the right man; answer, giving age, experience and copies of references. Box 503, POWER.

WANTED—First-class polyphase integrading Watt hour meter repair man; must be thoroughly familiar with adjustment and general meter theory; must also be capable of handling and repairing alternating- and direct-current motors; give reference, stating experience and full particulars concerning self with salary expected. Box 494, POWER.

WANTED—Superintendent to take charge of pattern shop, foundry and machine shop, or machine shop only, in plant employing about 250 men and manufacturing the highest class of large vertical gas engines; state past experience and salary demanded; none but men of highest proved ability will be considered. Address "G. E. 12," Care POWER.

SITUATIONS WANTED

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

CHIEF ENGINEER wants position; 18 years' experience, five years as chief engineer of power plant; can furnish best of references. Address Box 504, POWER.

ENGINEER desires change; has installed and handled some most economical running steam-electric power and lighting plants; holds A-1 references and certificates. Reply Box 502, POWER.

SUPERINTENDENT construction of complete steam plants—engines, turbines, condensers, boilers, etc.; superintendent of operation of large central stations and general power development; correspondence solicited. Box 501, POWER.

ENGINEER AND ELECTRICIAN wants steady position; is thirty-six years old, married and understands switchboards, dynamos, water turbines, steam, gas and ice-making machinery; best of references as to sobriety and reliability. Address Box 505, POWER.

AS CHIEF in plant of 1000 horsepower or smaller, or as assistant in larger; have fair technical education, first-class Indiana license and six years' continuous experience in the engine room; satisfaction guaranteed; 26 years old, married and strictly temperate; can furnish good reference; am employed at present as hoisting engineer. Address Box 500, POWER.

MISCELLANEOUS

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

PATENTS—C. L. Parker, Patent Attorney, ex-examiner Patent Office, 904 G St., Washington, D. C. Write for Inventor's Handbook.

WANTED—Agency by an engineering firm for a good and efficient water tube boiler for Illinois, North Indiana and Southern Wisconsin. Box 498, POWER.

AN ENGINEERING FIRM in Chicago wishes to take the agency for a reliable and efficient gas engine for producer gas; good references can be given. Box 497, POWER.

EVERY ENGINEER should be posted regarding the new system of vacuum heating installed without payment of royalty; I have valuable information; write today. T. L. Reeder, 1417 W. Jackson Blvd., Chicago, Ill.

FOR SALE

Advertisements under this head are inserted for 25 cents per line. About six words make a line.

FOR SALE—8x10 Skinner engine, direct connected to 30-kilowatt generator, and 8x10 Allfree engine, direct connected to 20-kilowatt generator. Address "Engineer," Box 2, Station A, Cincinnati, Ohio.

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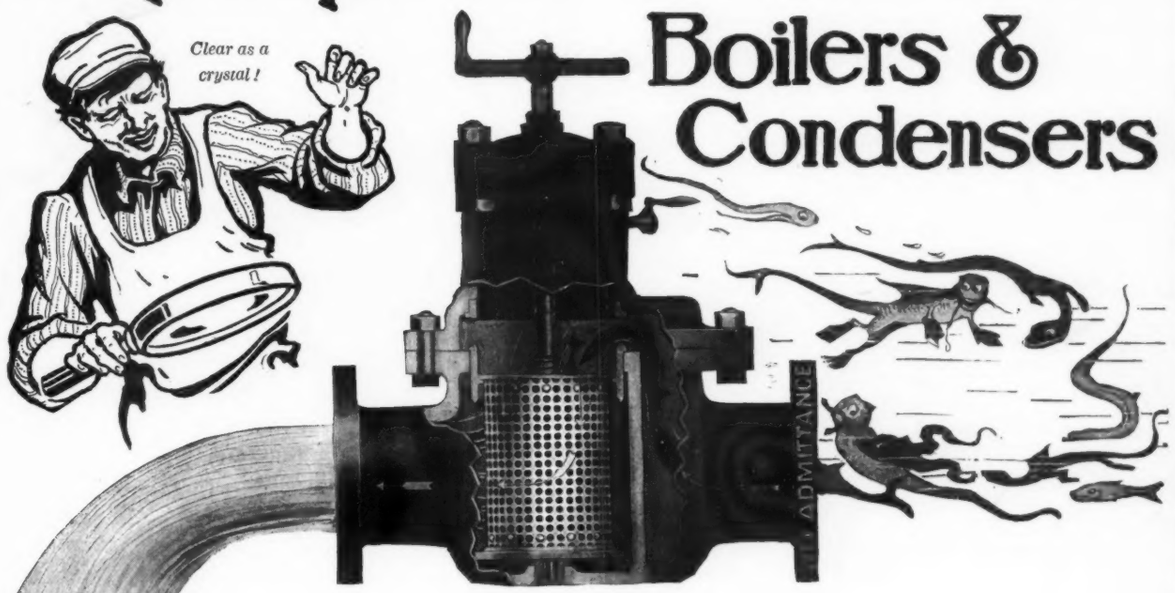

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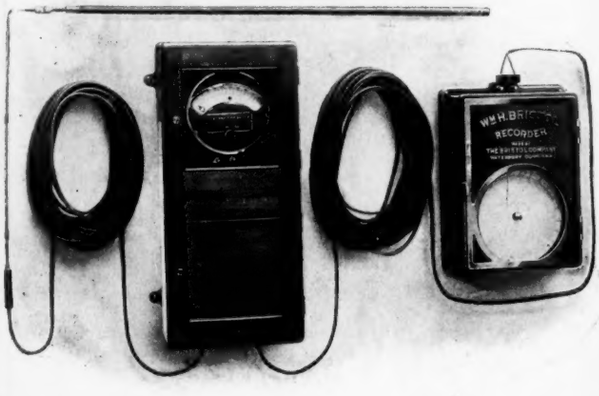

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